Dumitru Mihai

Sisteme de transport urban pe cale ferata
Proiecte

2019

Capitol 1 -Initiere in Ansys Workbench

Se deschide Ansys Workbench

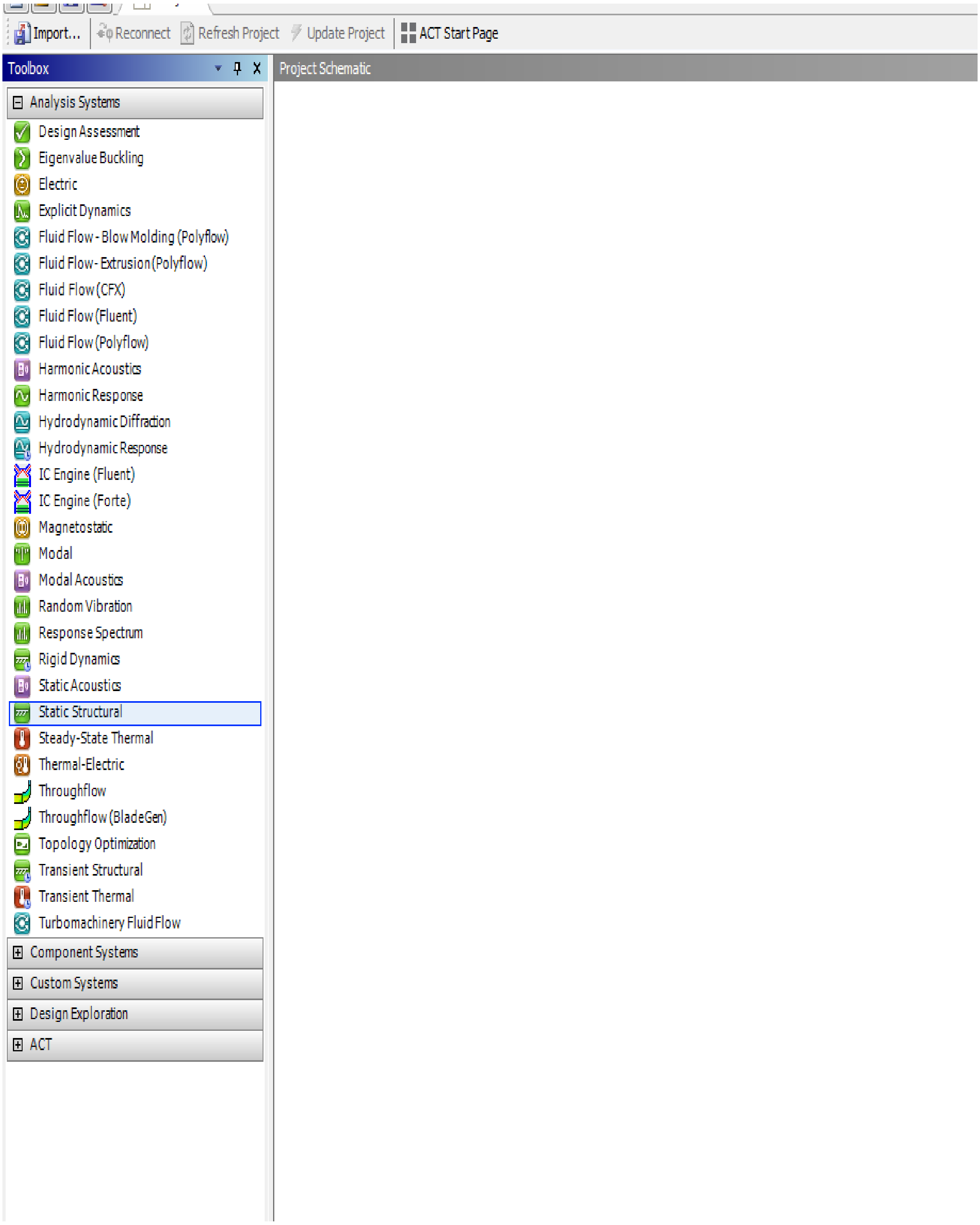


Figura 1- Deschiderea programului Ansys -Workbench

Se alege static structural mecanic si se da dublu clic, apare in dreapta o fereastra de dialog A

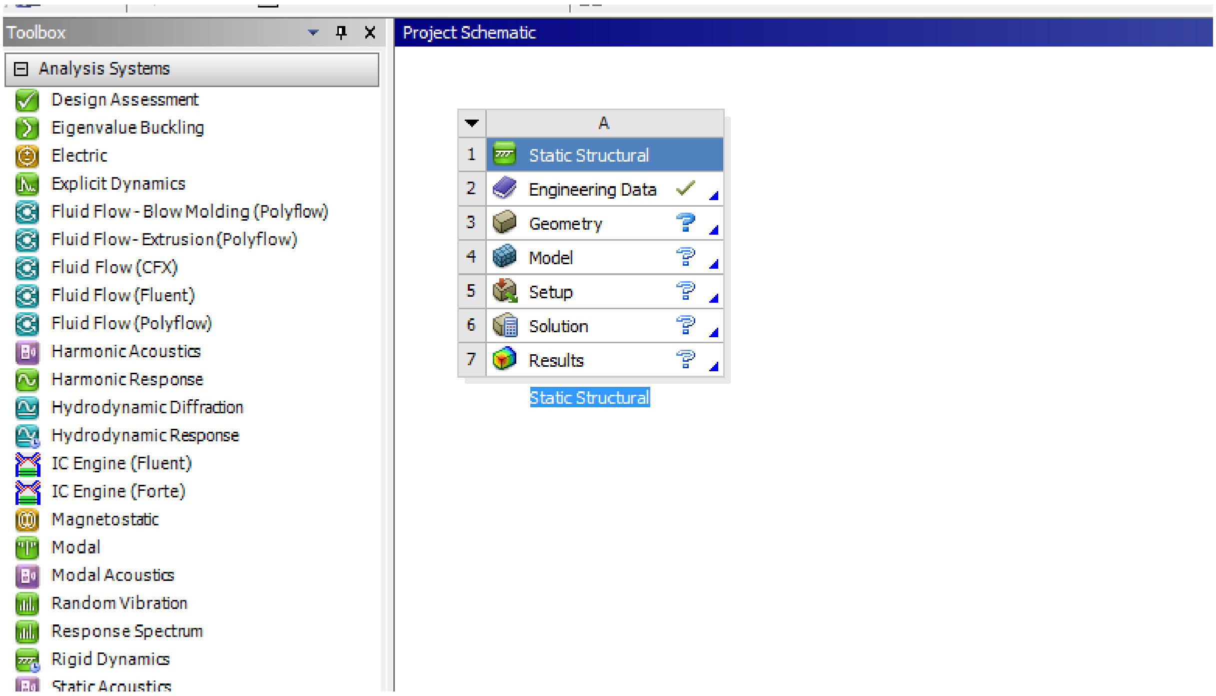


Figura 2- Deschiderea programului Ansys –Workbench-Project Schematic-A

Se da clic pe geometry –Import Geometry-browse

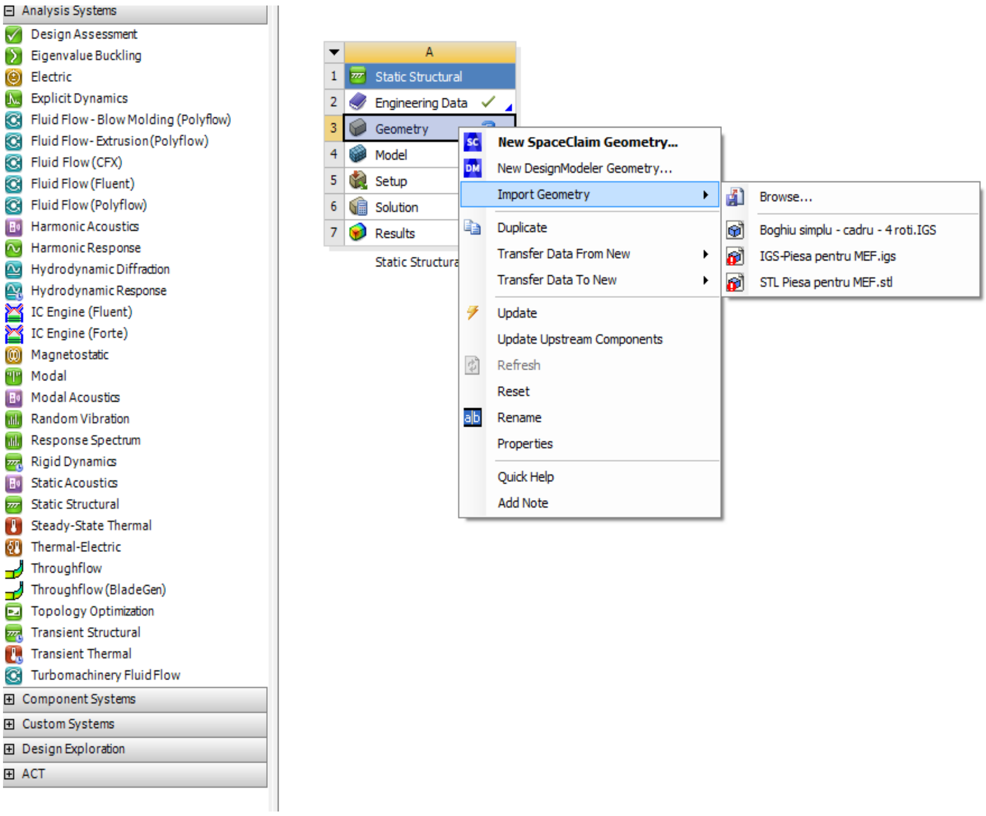


Figura 3- Deschiderea programului Ansys –Workbench-Project Schematic-A- Importarea geometrie

Din browse se duce in directorul unde este desenul si se da open

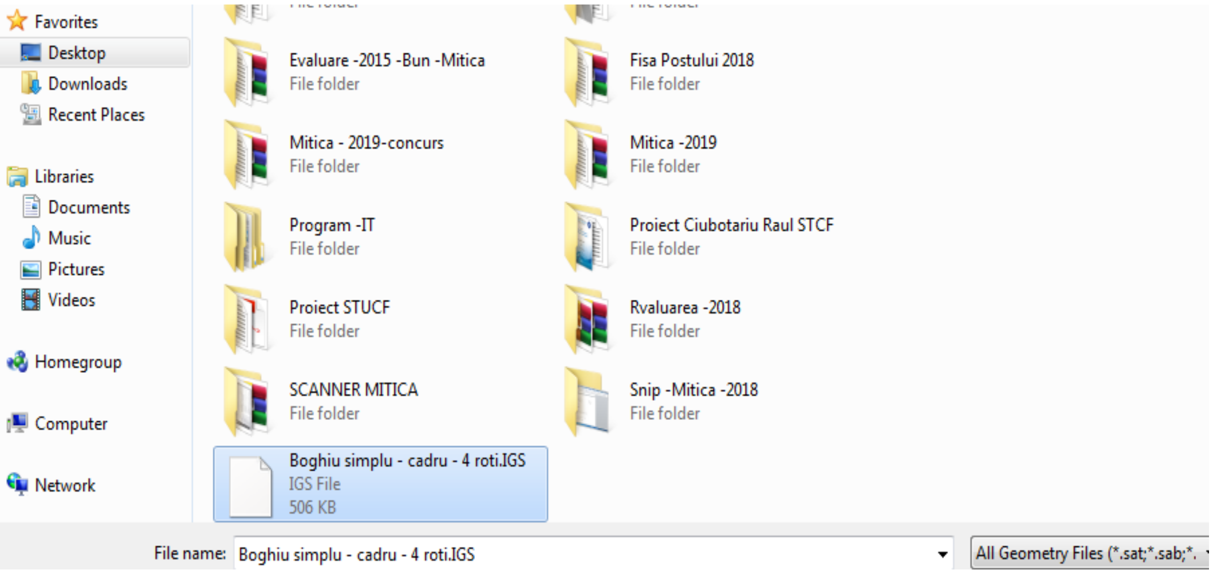


Figura 4- Deschiderea programului Ansys –Workbench-Project Schematic-A- Importarea geometrie dintr-un folder

Se da dublu clic pe model si se deaschide programul Ansys pentru calcul

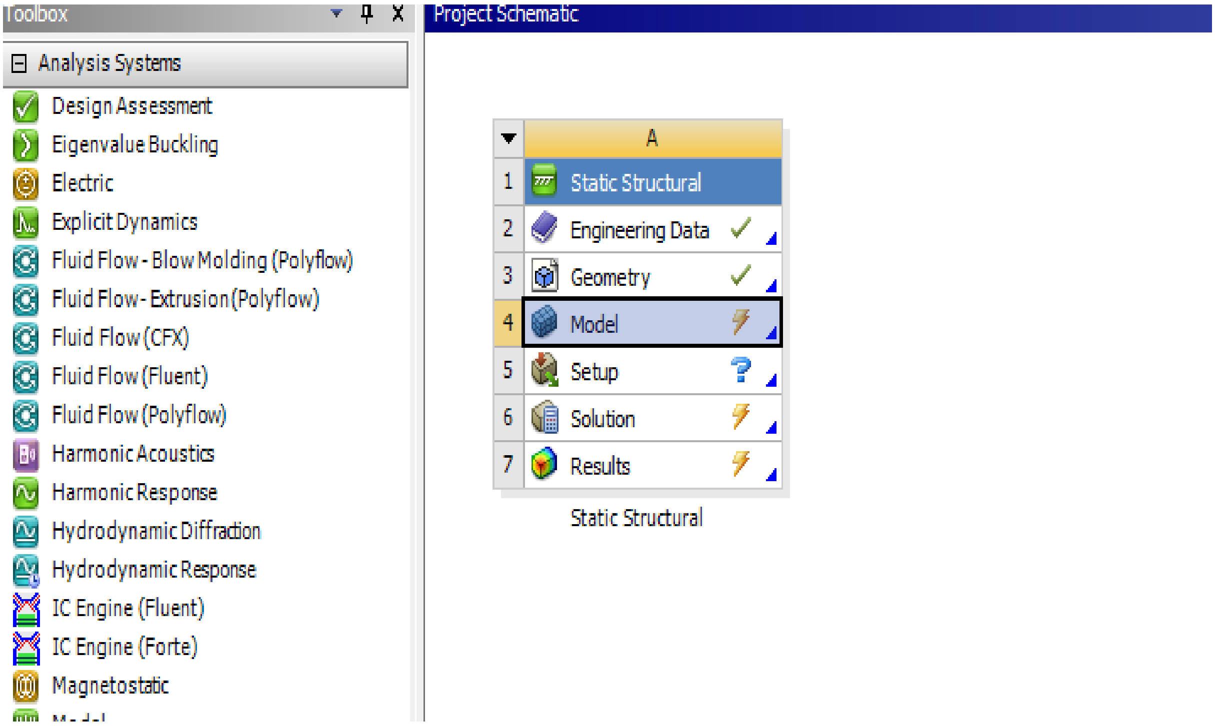


Figura 5- Deschiderea programului Ansys –Workbench-Project Schematic-A- Importarea geometrie dintr-un folder- Model

Se duce desenul in Project-Static Structural

La Geometry apare culoarea verde , rezulta ca geometria este buna , cand apare vreo problema apare culoarea rosie de atentionare.

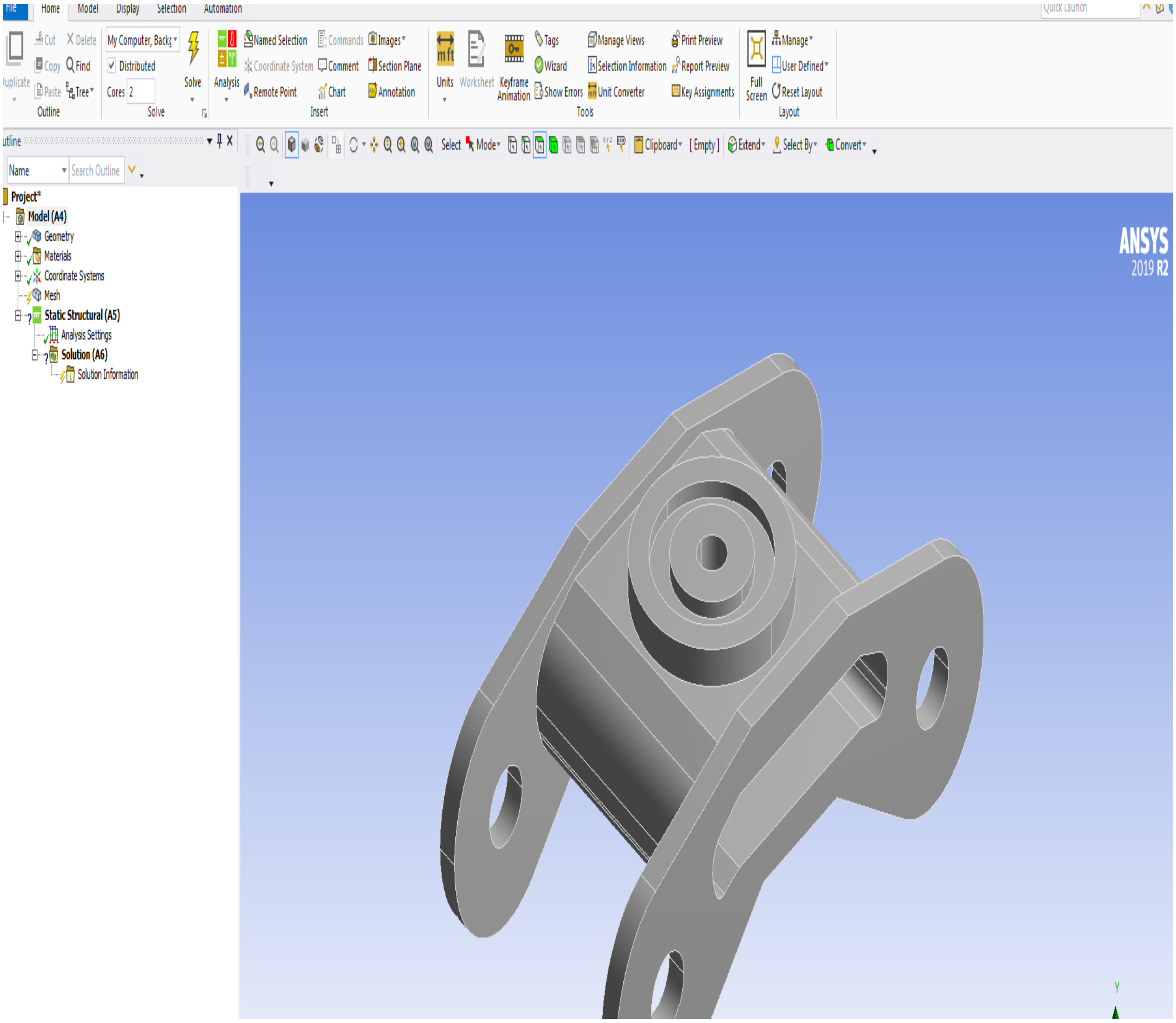


Figura 6- Deschiderea programului Ansys –Workbench-Project Schematic-A- Importarea geometrie dintr-un folder- Model-Project

Aici boghiul se reazema , se incarca , se pun in programul Ansys datele cautate si rezolvate : deformatiile; tensiunile etc.

Pas 1- se da dublu clic pe mesch , apare casuta de dialog pe care se da un clic pe Generate Mesch.

Aici se face o discretizare grosolana .

Mesh are culoare verde , este bun .

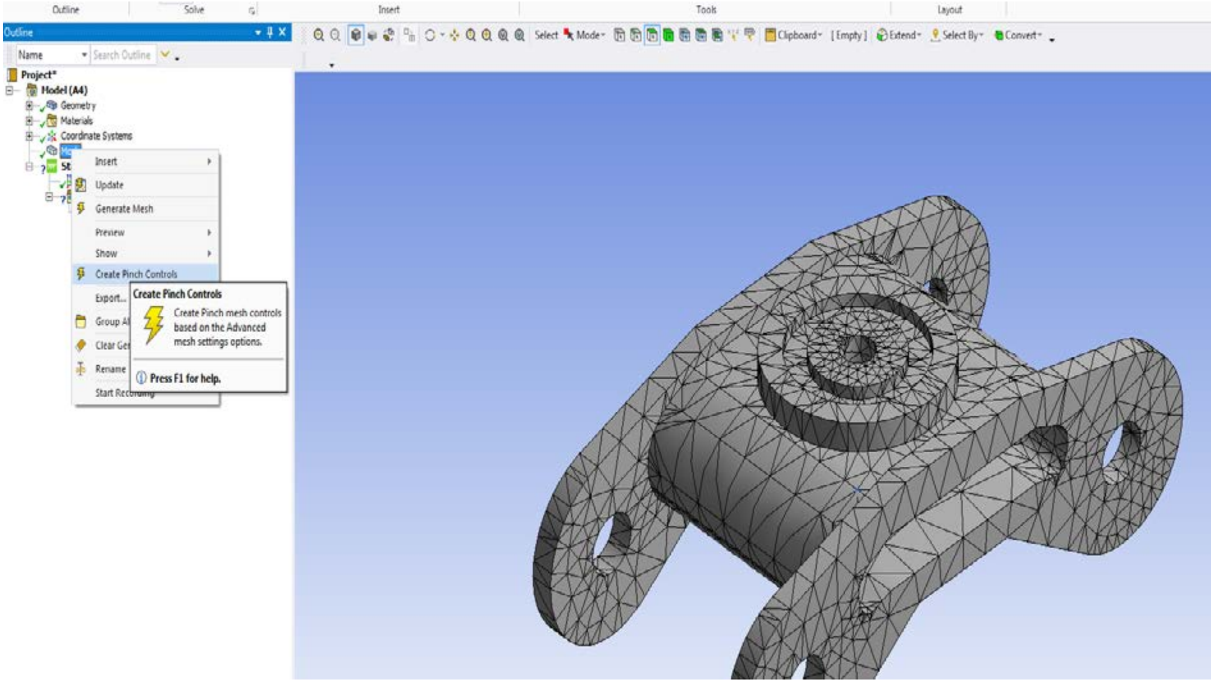


Figura 7-Project –Model-Mesch finalizat

Se merge din Project la Static Structural

<u>Static structural mecanic</u>

Pas 2-Reazemul boghiului

- Sus ne arata ca am ales suprafete (pot avea toata piesa , muchii , varfuri);
- Apoi cu mausul am ales suprafetele de reazem (se ia mai multe suprafete cu CTRL apasat de la maus)

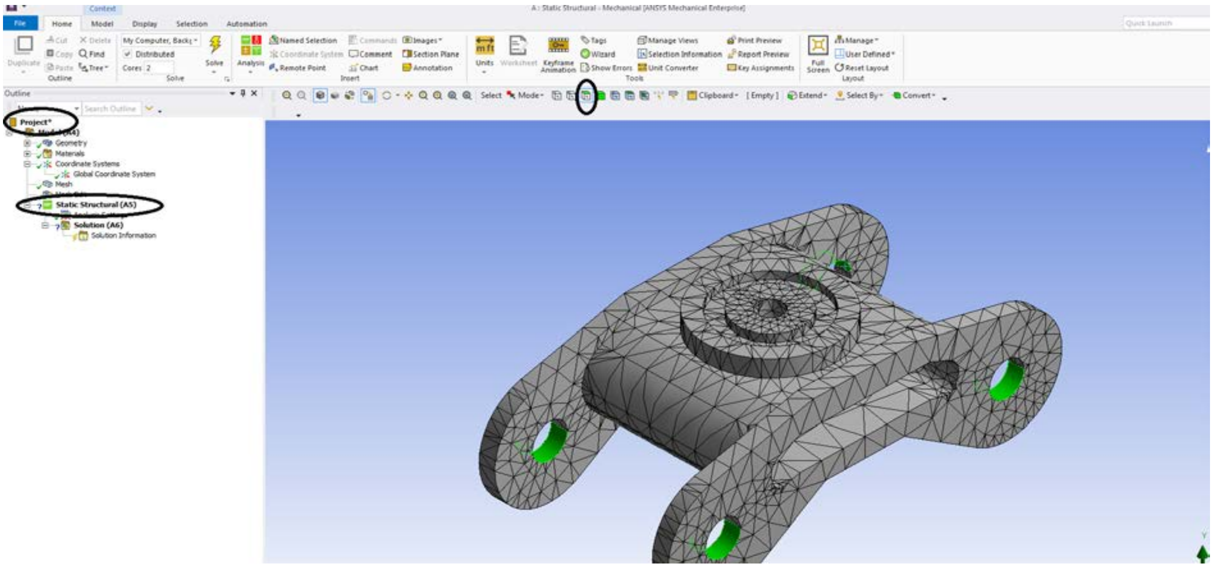


Figura 8-Project –Model-Mesch finalizat-Reazem (Fixed Support)

In Project se merge jos la Static Structural se da clic dreapta si apare – Insert – Acceleraton...Fixed Support

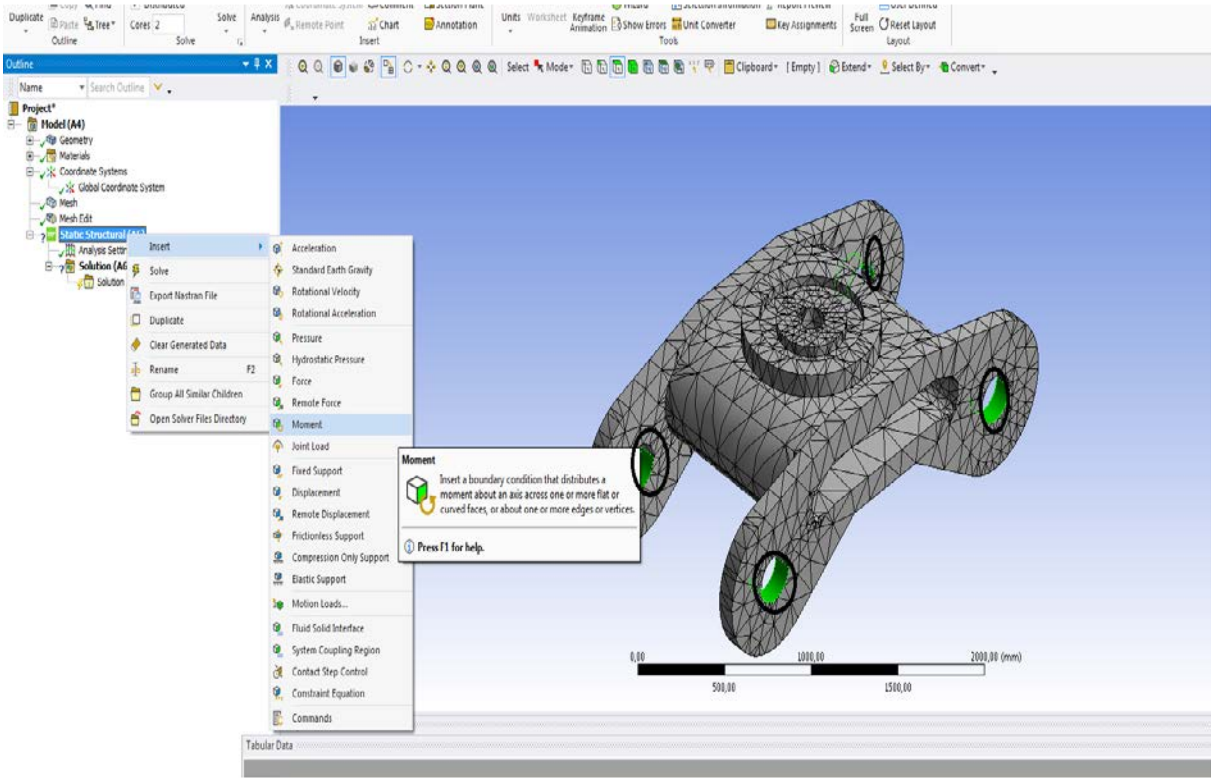


Figura 9-Project –Model-Mesch finalizat-Reazem (Fixed Support) in lucru

Am pus reazem incastrat in toate patru suprafetele.

La reazem apare culoarea verde , este bun asa.

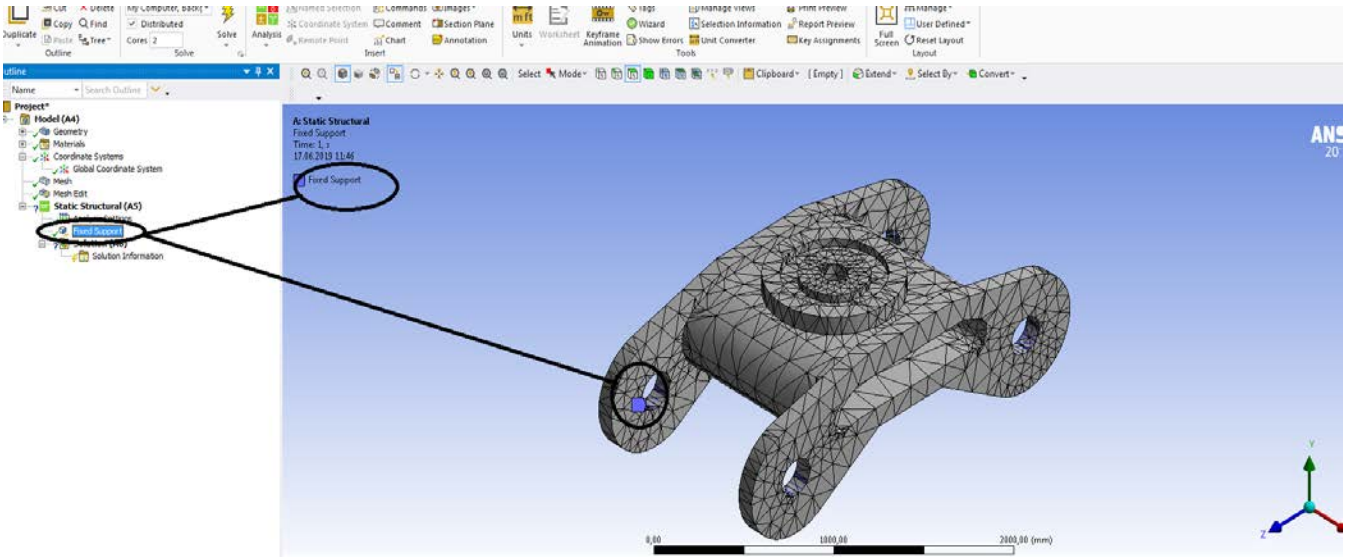


Figura 10-Project –Model-Mesch finalizat-Reazem (Fixed Support) finalizat

Pas 3 – Boghiul este supus la solicitari mecanice

- **De sus se alege suprafata;**
- **S-a ales sistemul de referinta;**
- **Se incarca pe suprafata aleasa (suprafata verde) cu o forta concentrata F.**

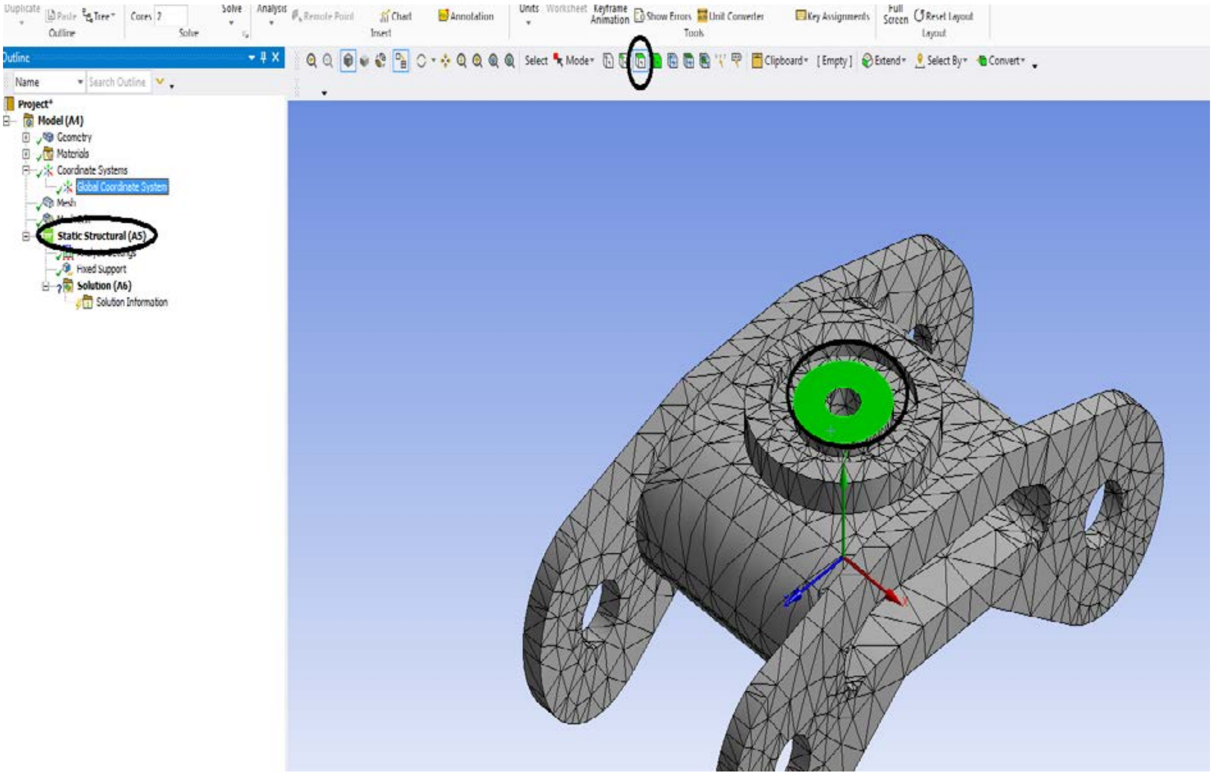


Figura 11-Project –Model (A4) – Static Structural (A5)- selectez suprafata de incarcare pentru: forte, momente , temperaturi etc.

Static Structural –clic dreapta –Insert-Force- clic drepata pe Force

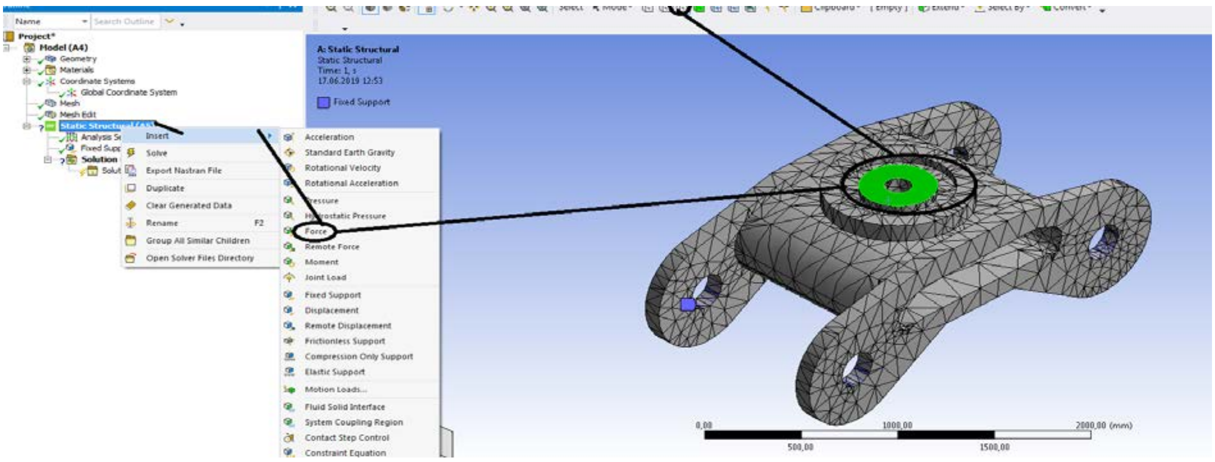


Figura 12-Project –Model (A4) – Static Structural (A5)- selectez suprafata de incarcare pentru forta

Apare casuta de jos stanga pentru forta concentrata F aplicata boghiului pe suprafata aleasa

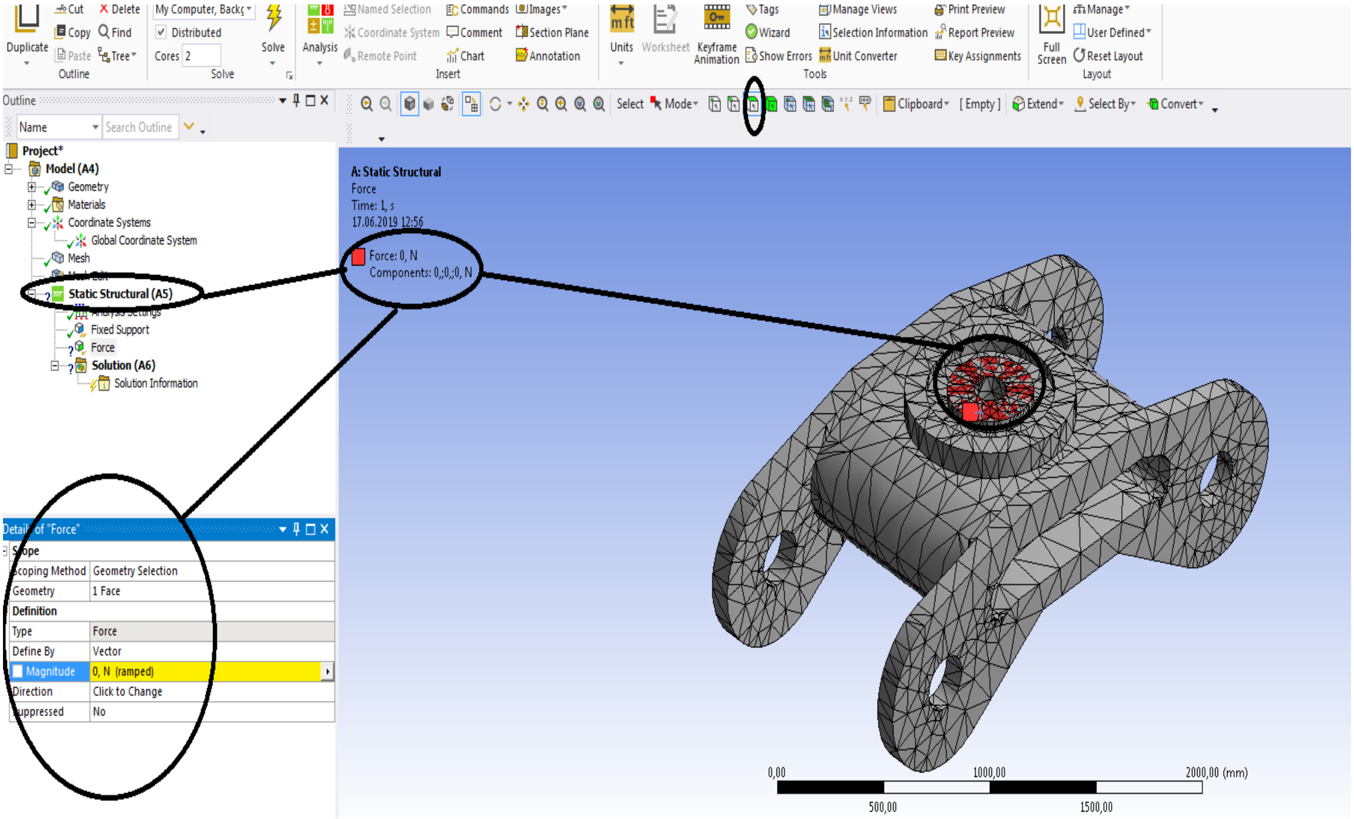


Figura 13-Project –Model (A4) – Static Structural (A5)- Detail of „Force”

Se duce la casuta de jos la Force (forta) , se da vector si componente

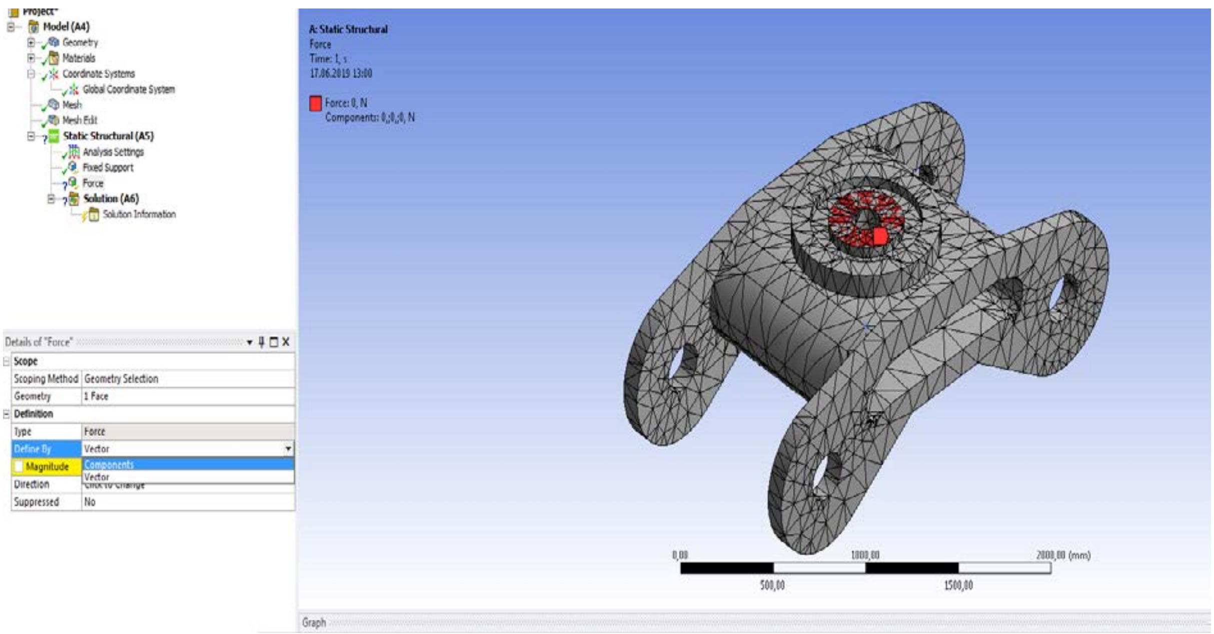


Figura 14-Project –Model (A4) – Static Structural (A5)- Detail of „Force”- Forta pe componente

Se pune forta F = - 600.000 N, apoi se da enter

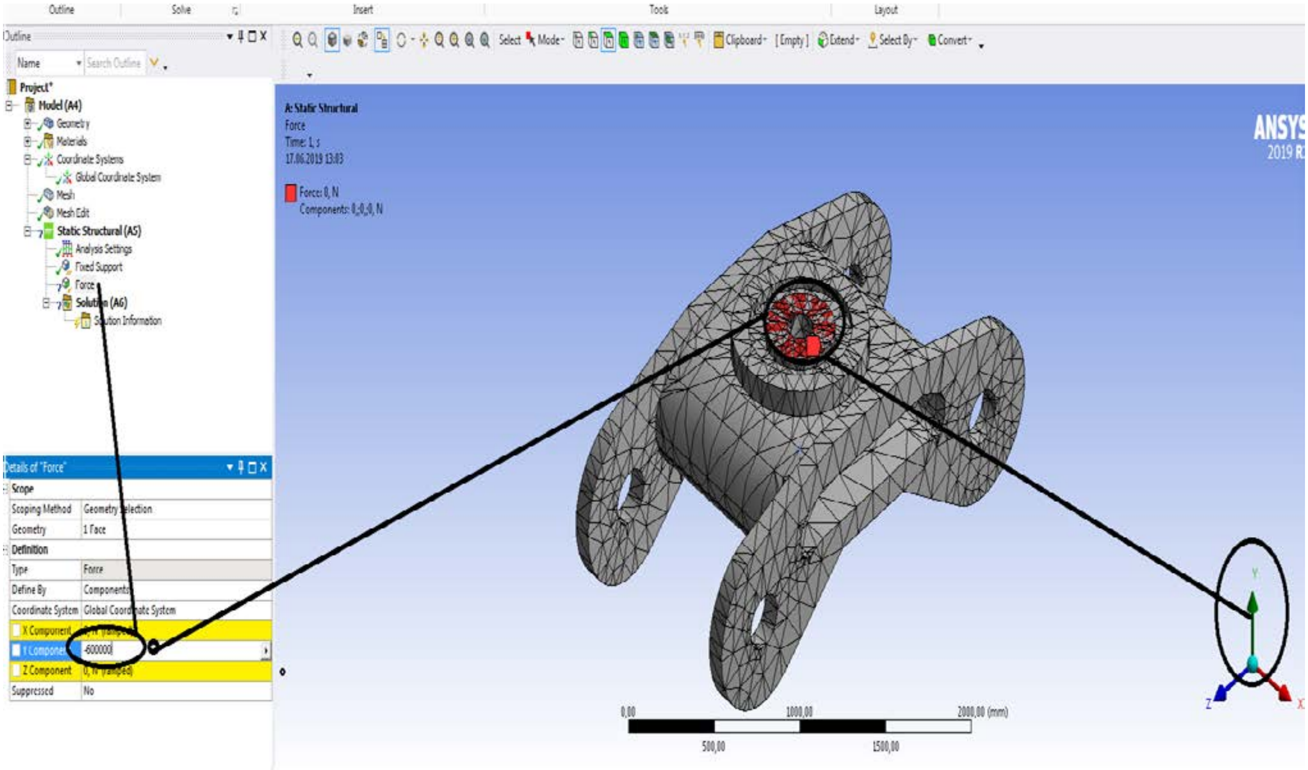


Figura 15-Project –Model (A4) – Static Structural (A5)- Detail of „Force”- Forta pe componente finalizata

S-a pus o forta de 600.000 N , apare culoarea verde , la fel la geometrie , la mesch, la reazem culoarea verde ne spune ca-i buna solutia aleasa de noi.

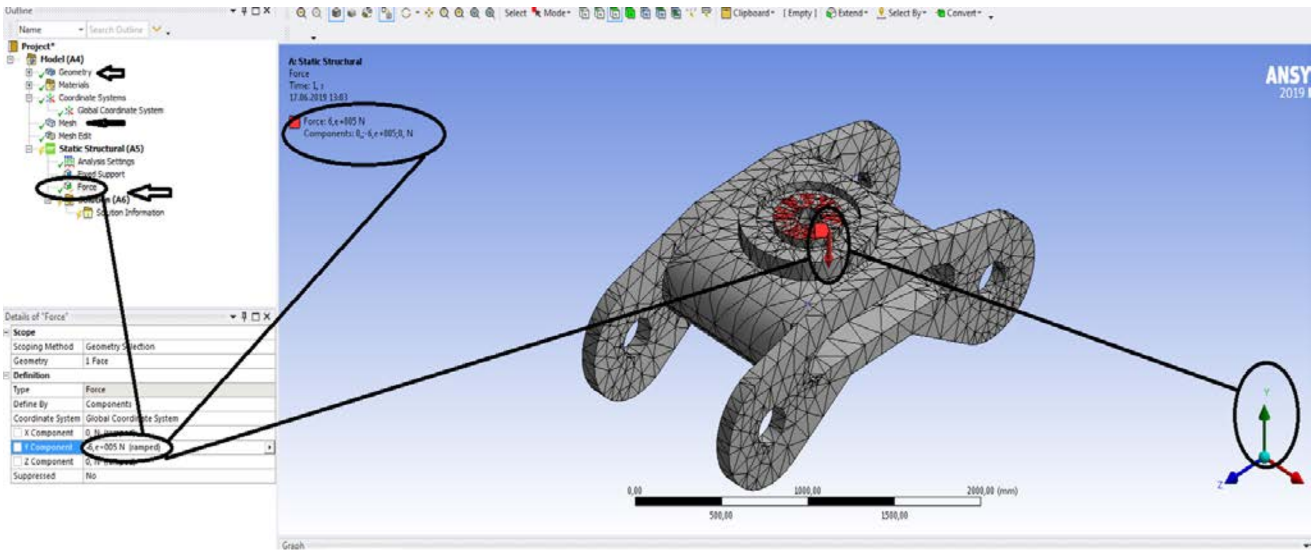


Figura 16-Project –Model (A4) – Static Structural (A5)- Detail of „Force”- Forta pe componente finalizata si explicata

Pas 4 – Solutii

- **Deformatii totale ;**
- **Deformatii directionale;**
- **Deformatii specifice von Mises;**
- **Deformatii specifice principale maxime ε_1 ;**
- **Deformatii specifice principale ε_2 ;**
- **Deformatii specifice principale minime ε_3 ;**
- **Tensiuni von Mises;**
- **Tensiuni nomale principale maxime.**

Pentru deformatii totale si directionale

Clic dreapta pe solution (A6) si apar insert- deformations –totale sau directionale

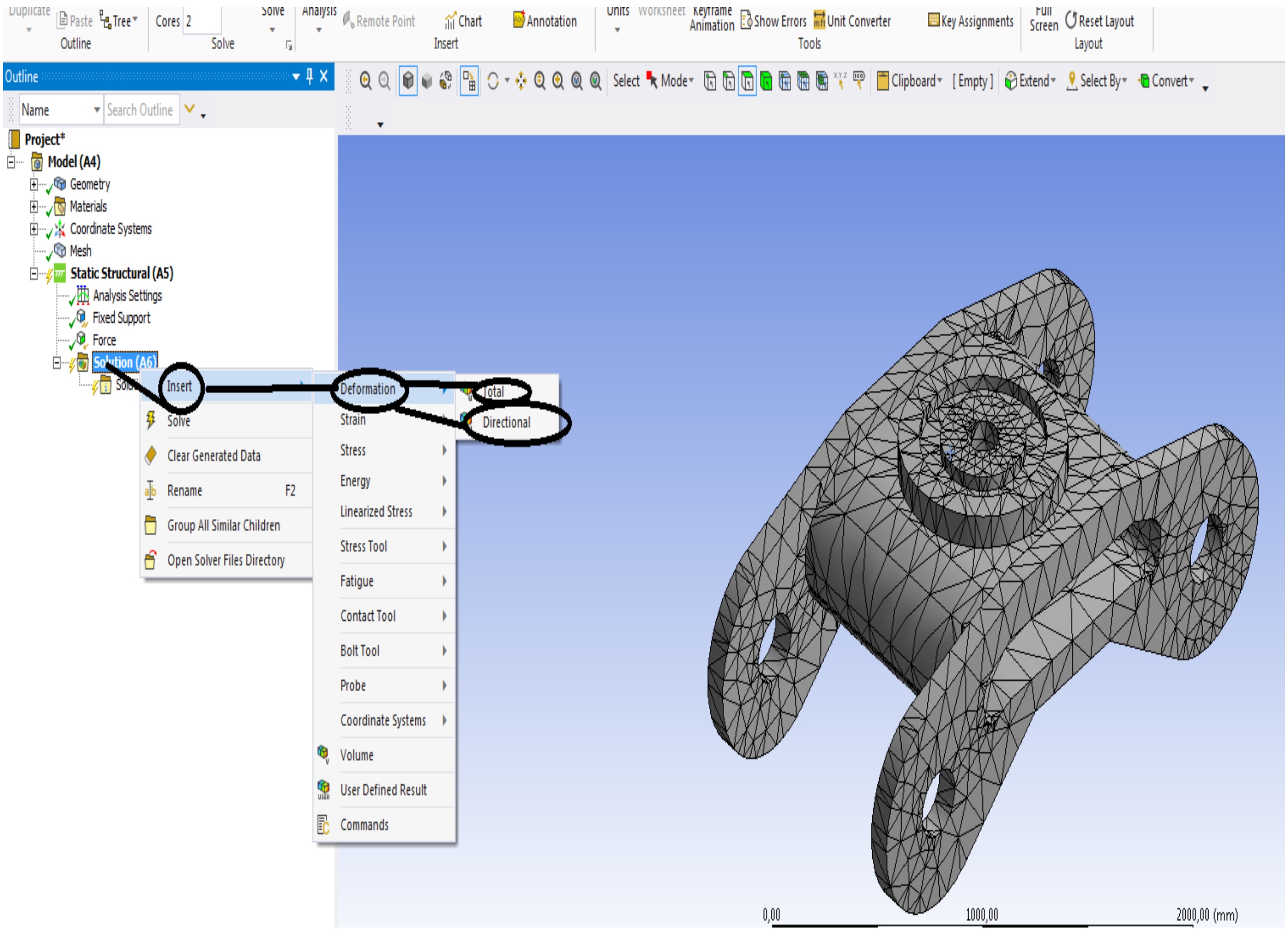


Figura 17-Project –Model (A4) – Static Structural (A5)-Solution (A6)

Clic dreapta pe solution (A6) si apar insert- deformations –totale sau directionale , se da clic pe deformatii totale si apare la solutii, la fel si cu deformatiile directionale

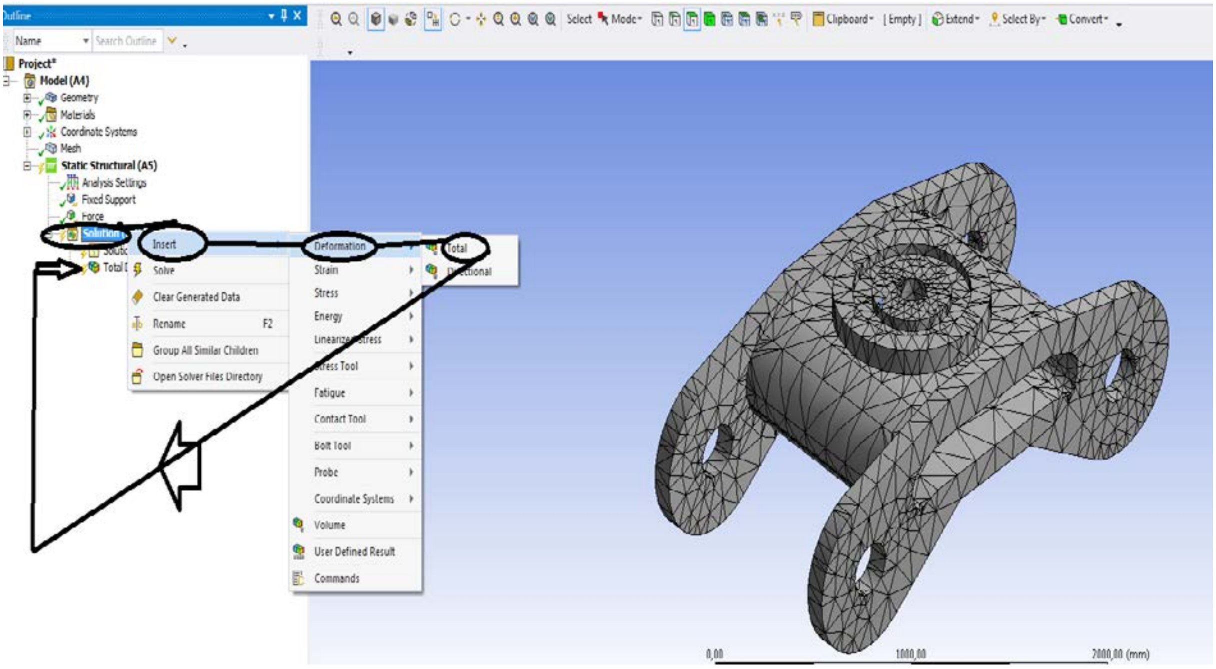


Figura 18-Project –Model (A4) – Static Structural (A5)-Solution (A6)-Insert- Deformatii totale

Clic dreapta pe solution (A6) si apar insert- Strain –echivalent von Mises , se da clic echivalent von Mises si vor apare la solutii jos

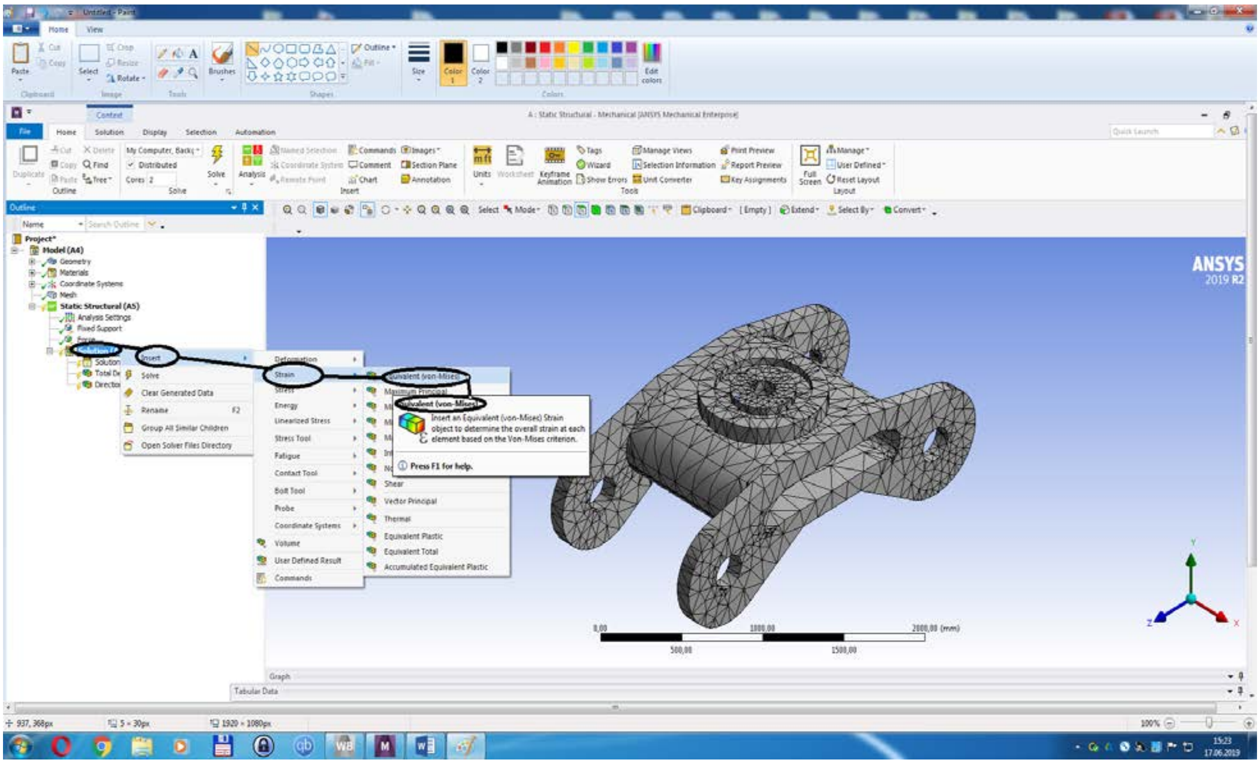


Figura 19-Project –Model (A4) – Static Structural (A5)-Solution (A6)-Insert- Strain-Strain echivalent

Clic dreapta pe solution (A6) si apar insert- Strain –Maximum Principal , se da clic Maximum Principal si vor apare la solutii jos

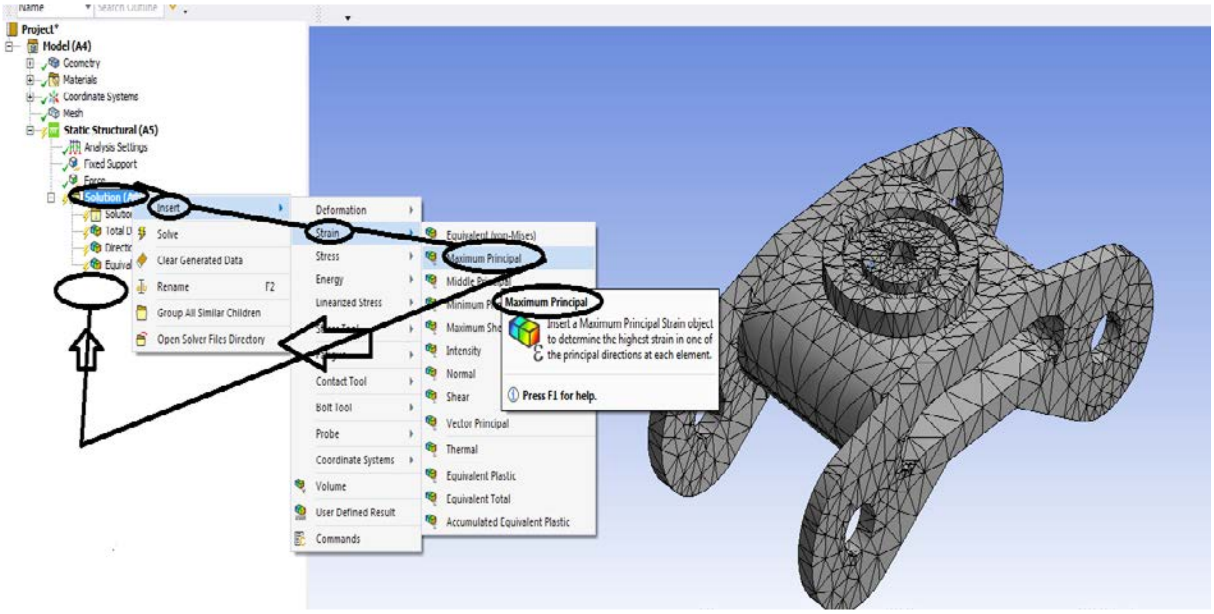


Figura 20-Project –Model (A4) – Static Structural (A5)-Solution (A6)-Insert- Strain-Strain Maximum Principal

Clic dreapta pe solution (A6) si apar insert- Stress –Minimum Principal , se da clic Minimum Principal si vor apare la solutii jos

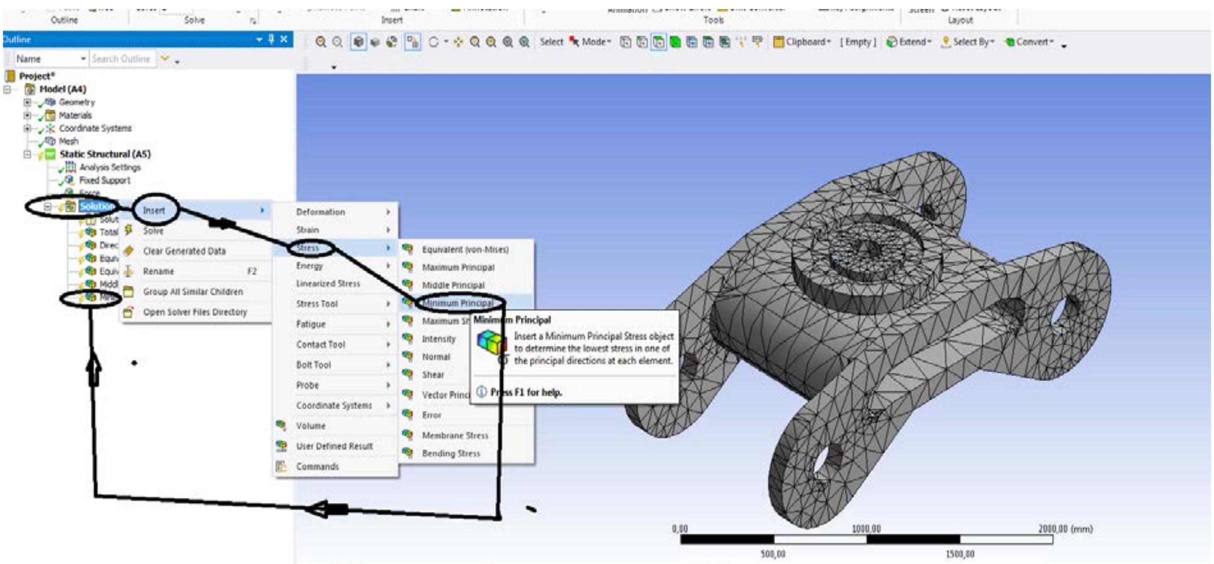


Figura 21-Project –Model (A4) – Static Structural (A5)-Solution (A6)-Insert- Stress-Stress Maximum Principal

1.2 Rezultate static structural mecanic boghiu

Solution (A6)- clic pe Solve

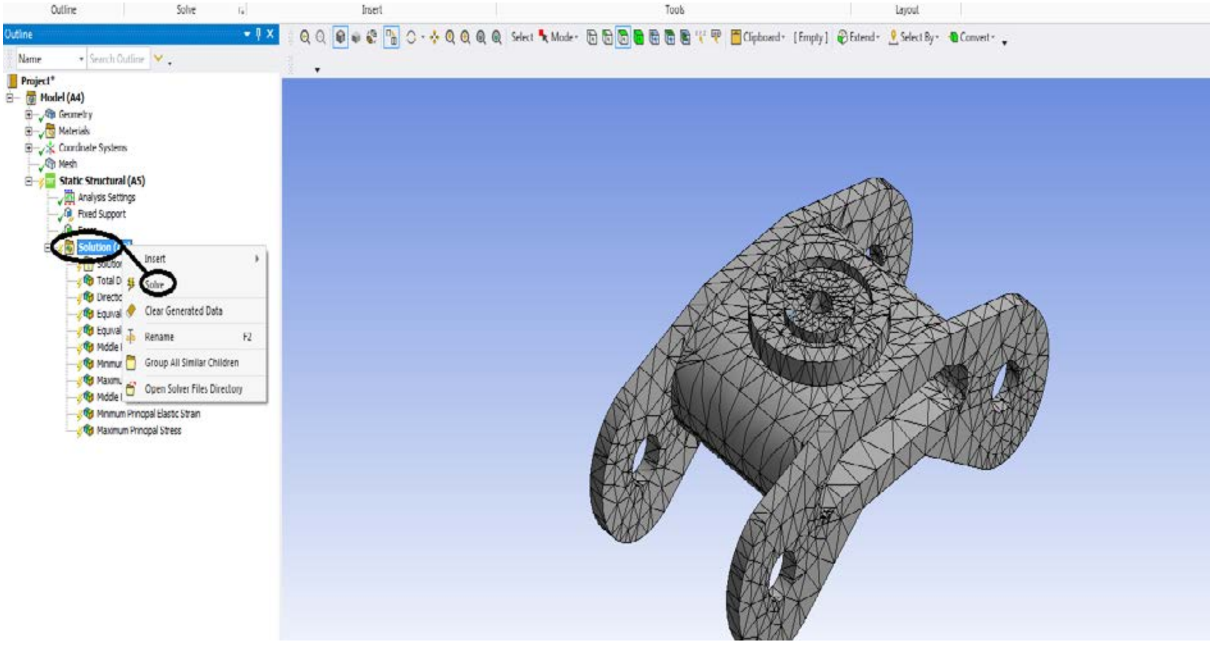


Figura 22-Project –Model (A4) – Static Structural (A5)-Solution (A6)- Solve

Solution (A6)- Solve-Evaluate ALL Results- clic Get results
Si apar solutiile finale

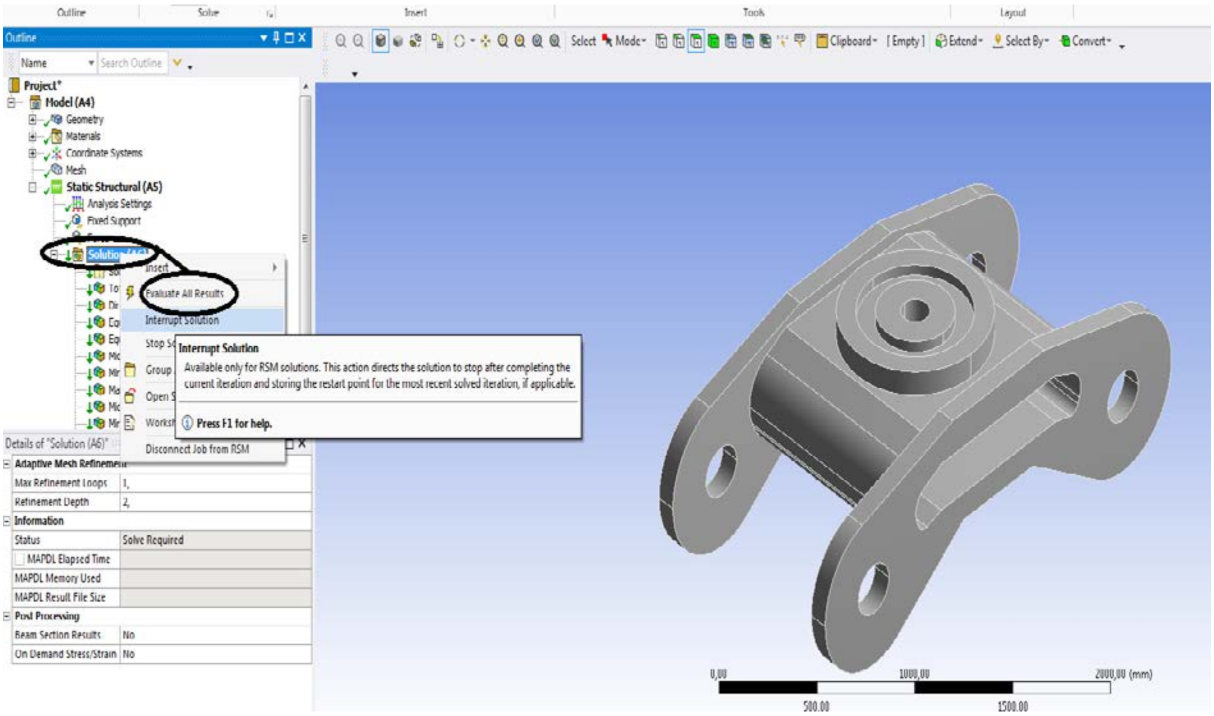


Figura 23-Project –Model (A4) – Static Structural (A5)-Solution (A6)- Solve-Get results

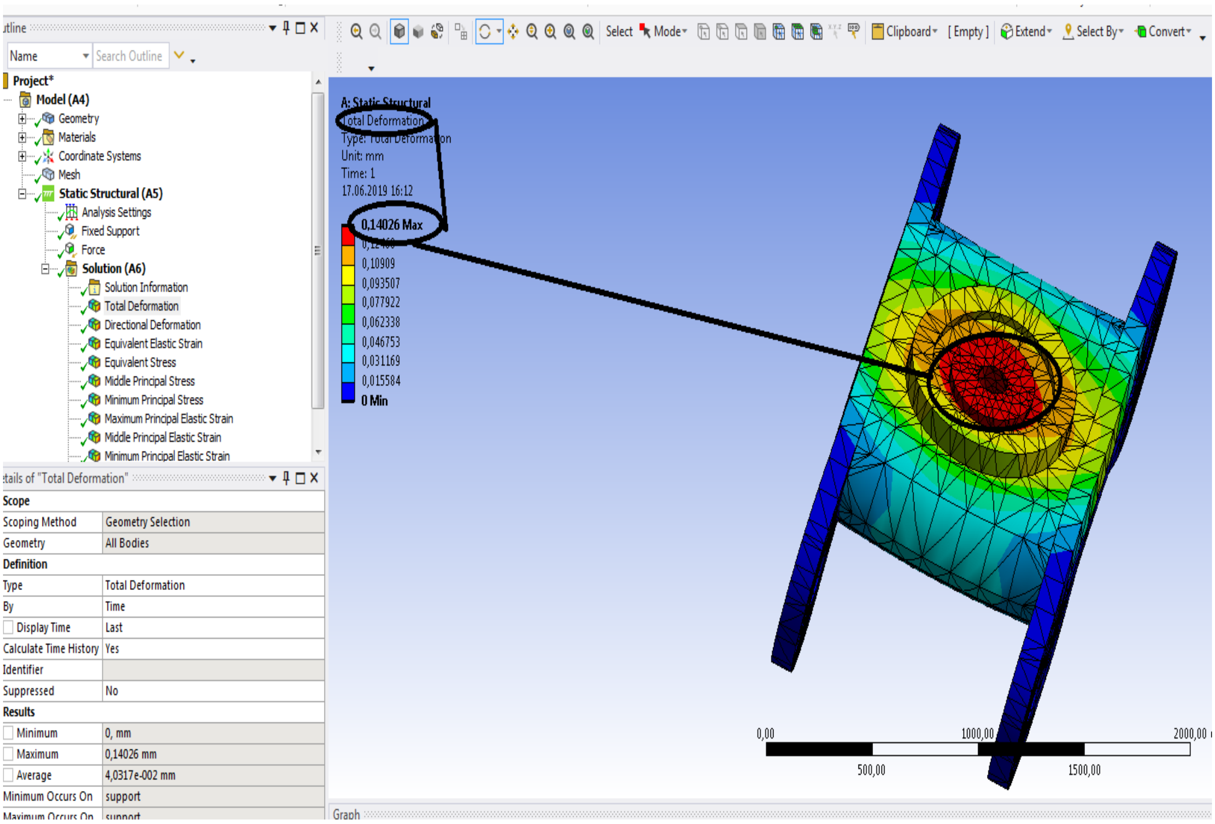


Figura 24 - Deformatii totale [mm]

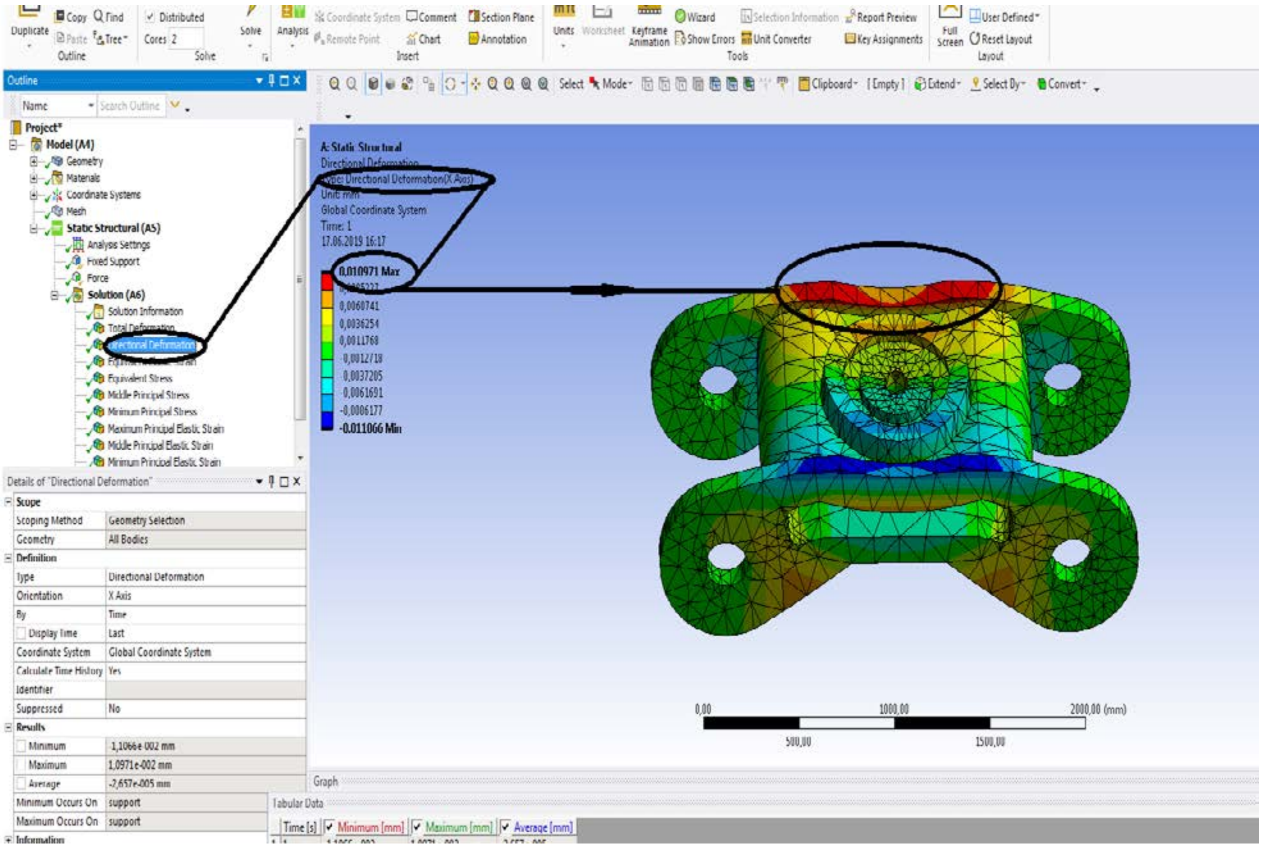


Figura 25- Deformatii dupa axa OX [mm]

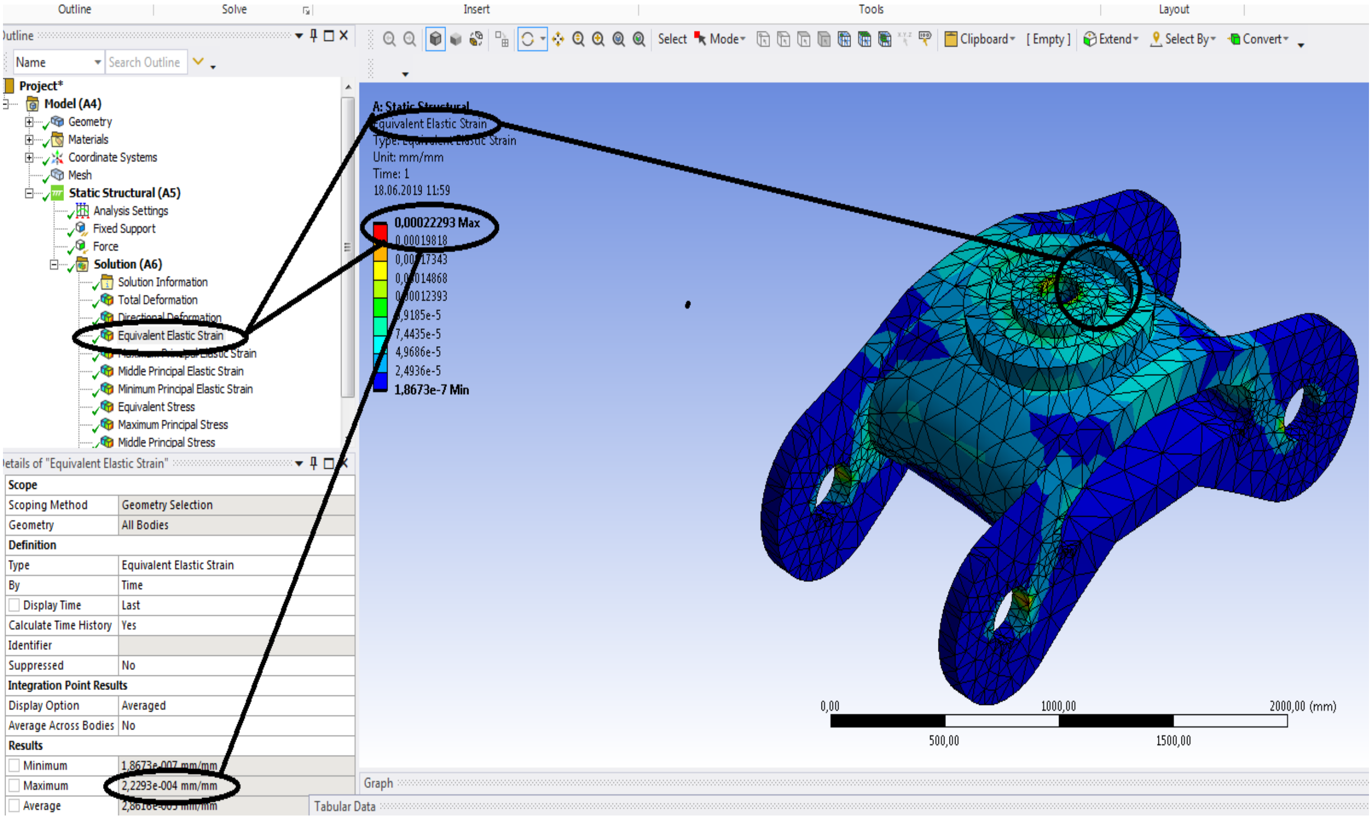


Figura 26 - Deformațiile specifice echivalente ε [mm/mm]

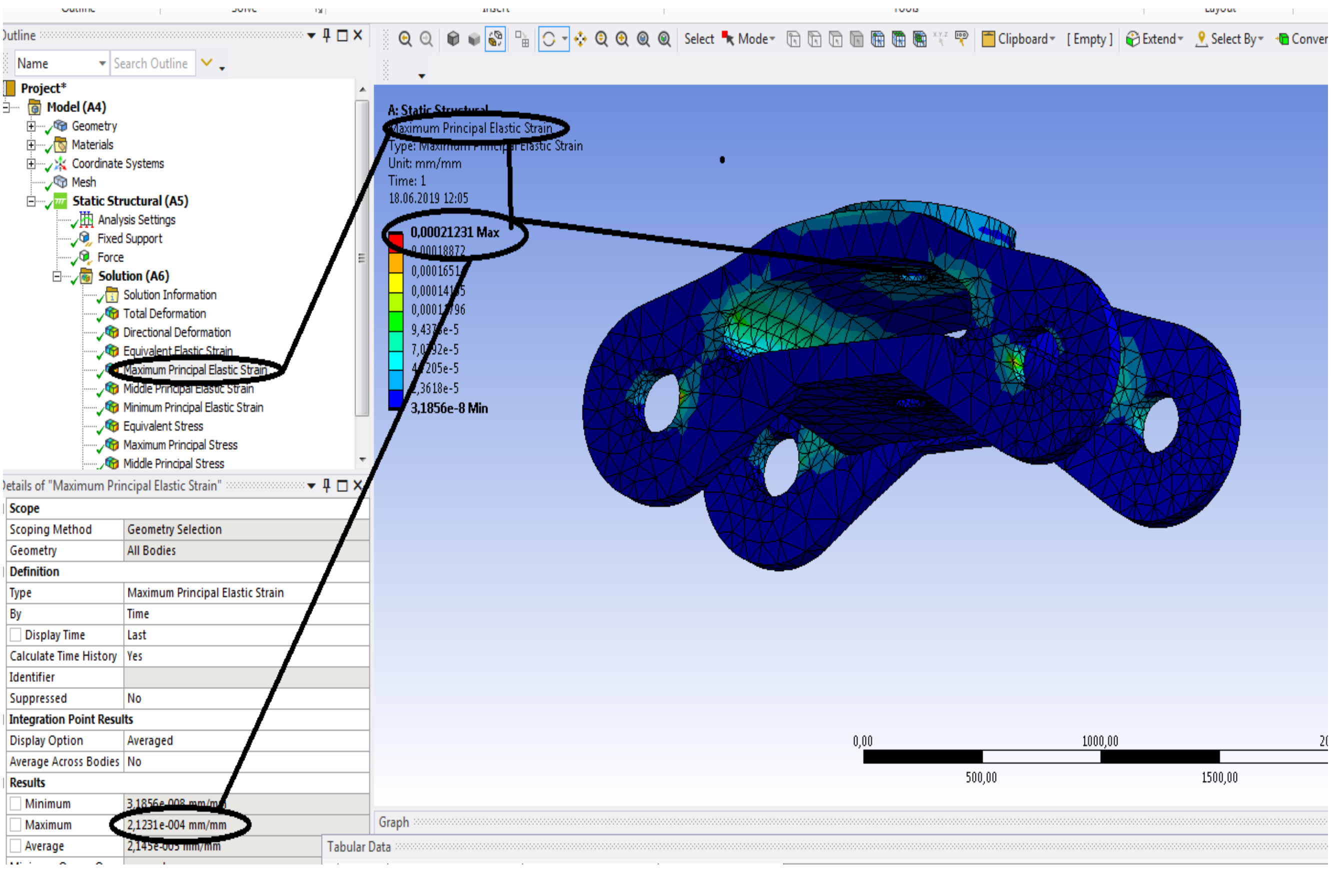


Figura 27- Deformațiile specifice principale - ε1 [mm/mm]

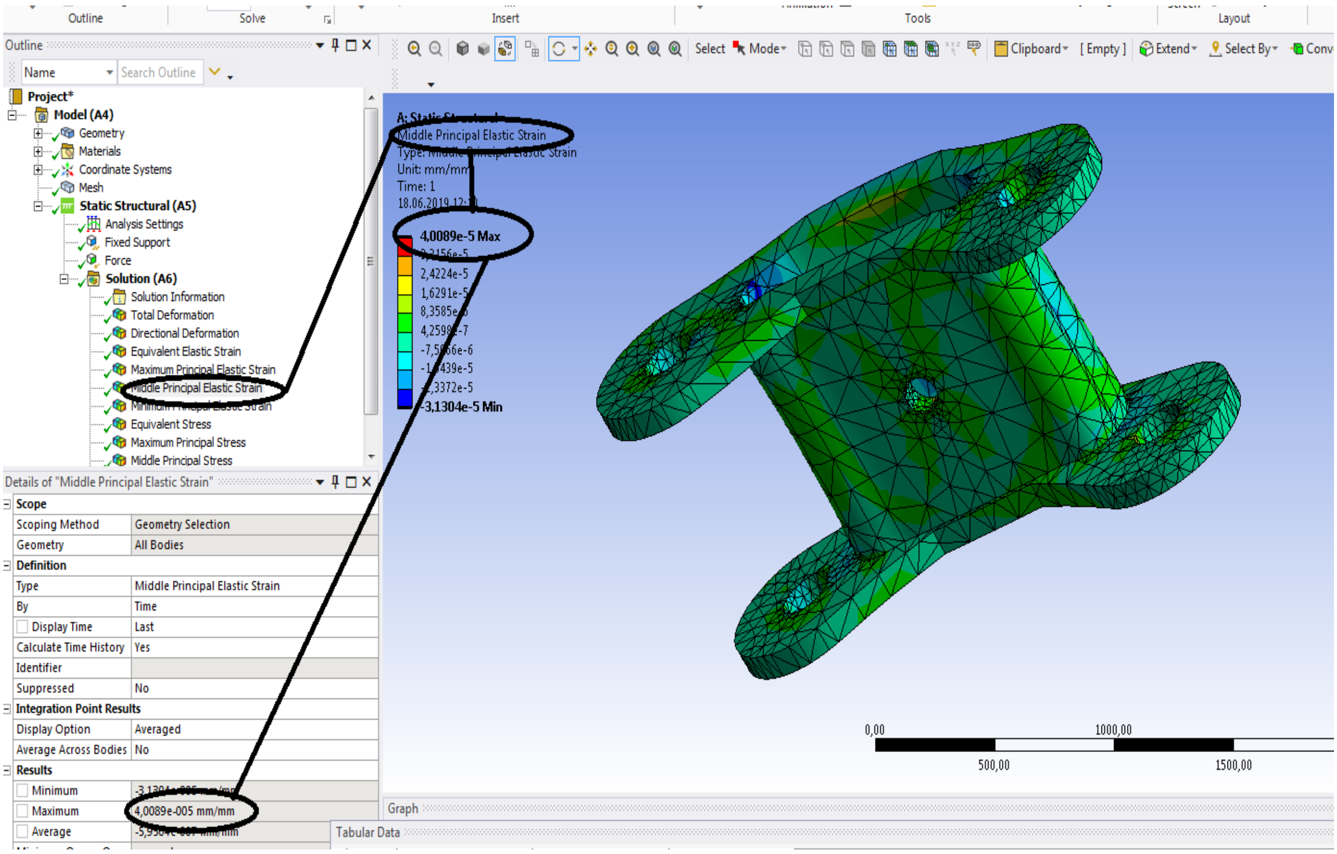


Figura 28 - Deformațiile specifice principale ε2 [mm/mm]

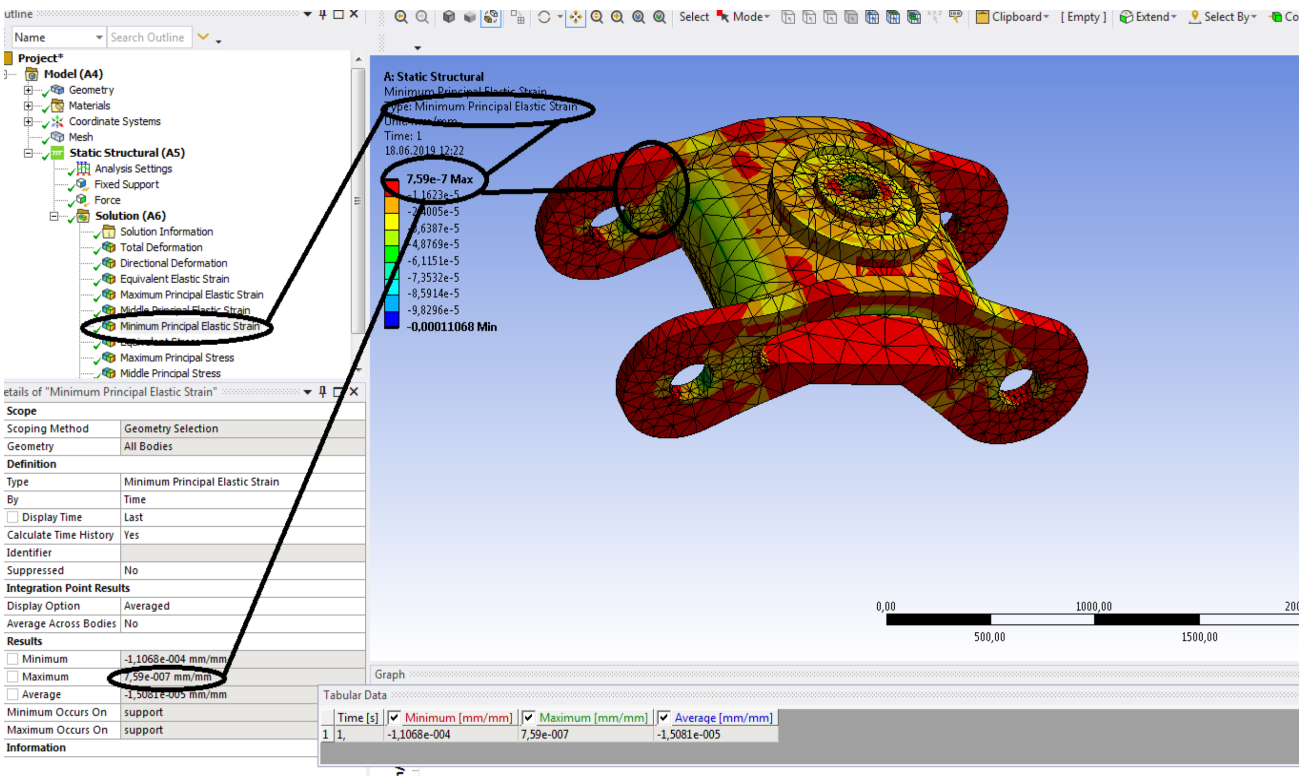


Figura 29- Deformațiile specifice principale ε3 [mm/mm]

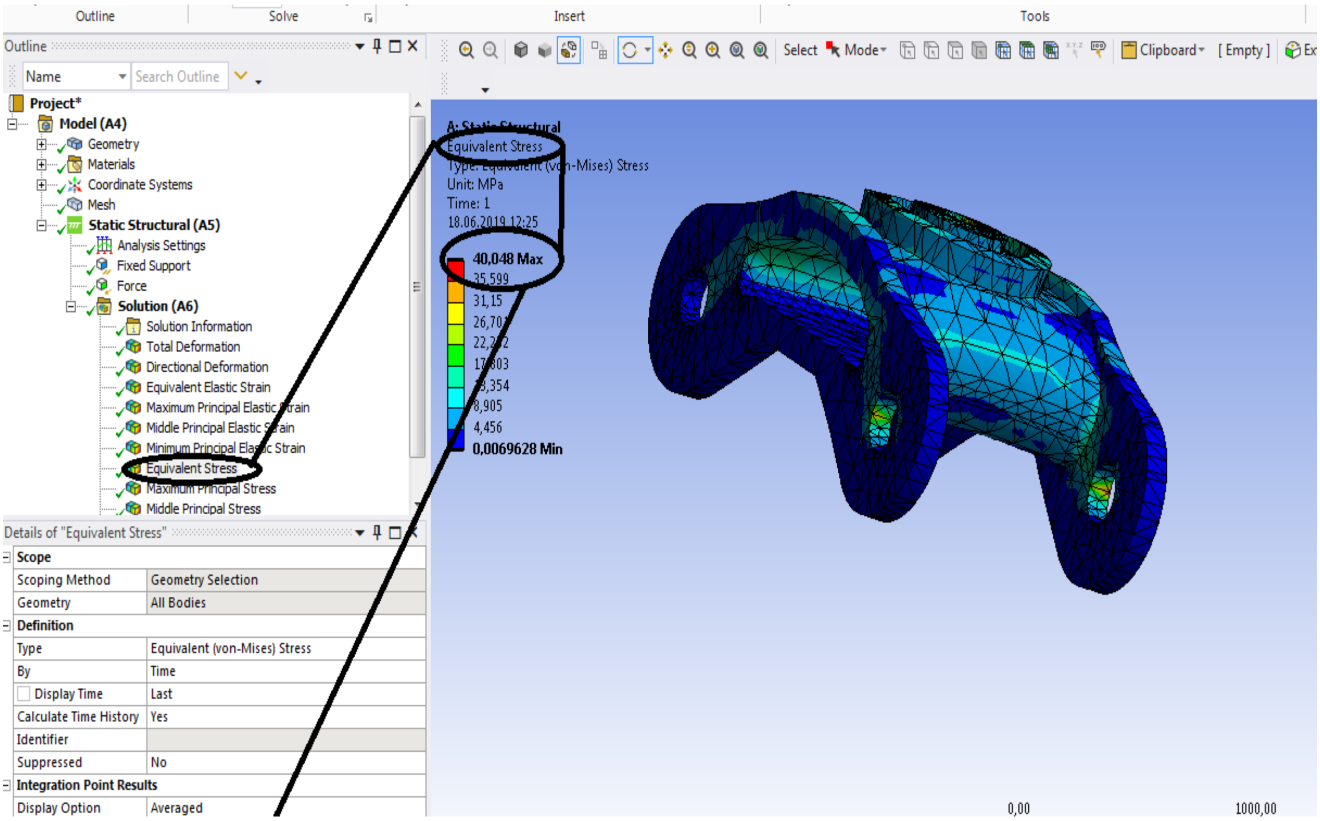


Figura 30- Tensiunile echivalente von Mises [MPa]

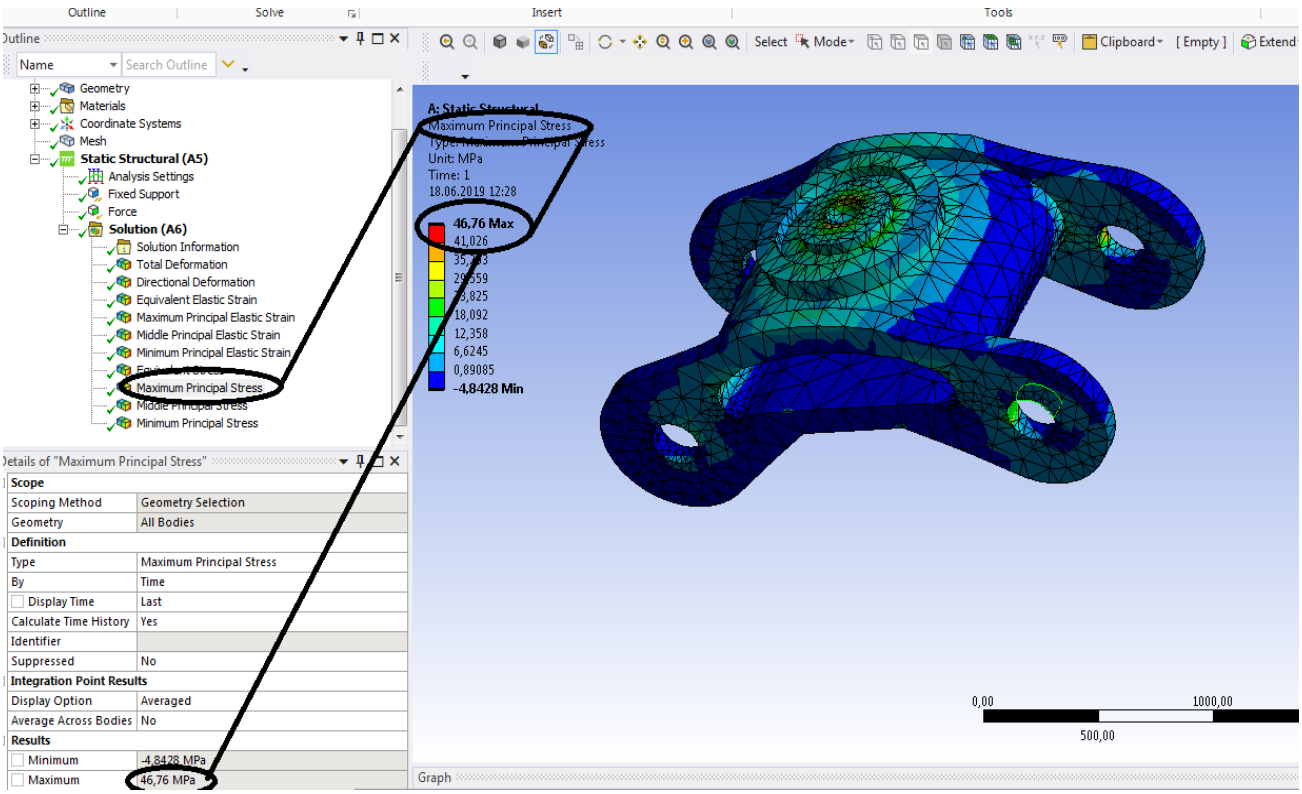


Figura 31- Tensiunile principale $\sigma 1$ [MPa]

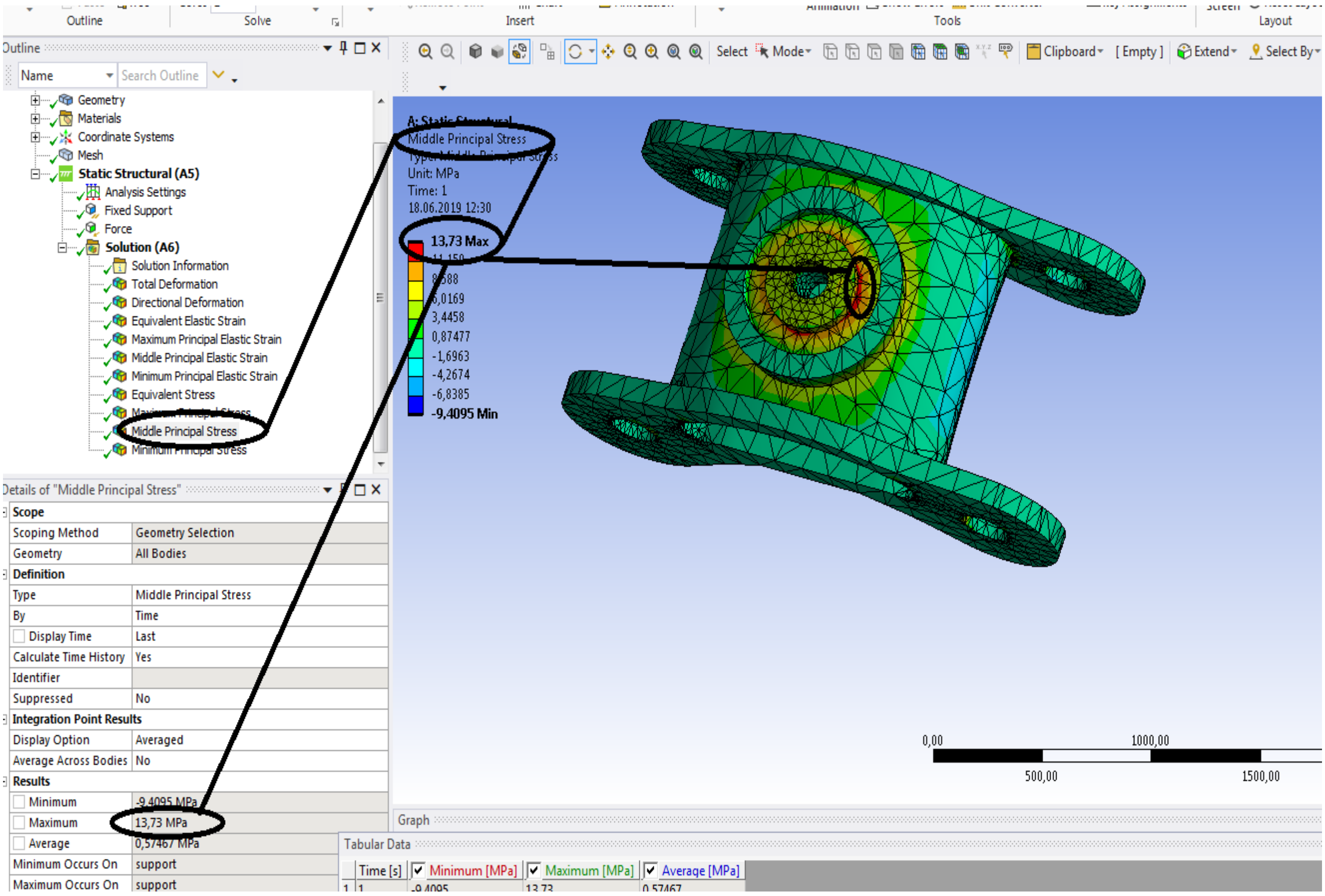


Figura 32- Tensiunile principale $\sigma 2$ [MPa]

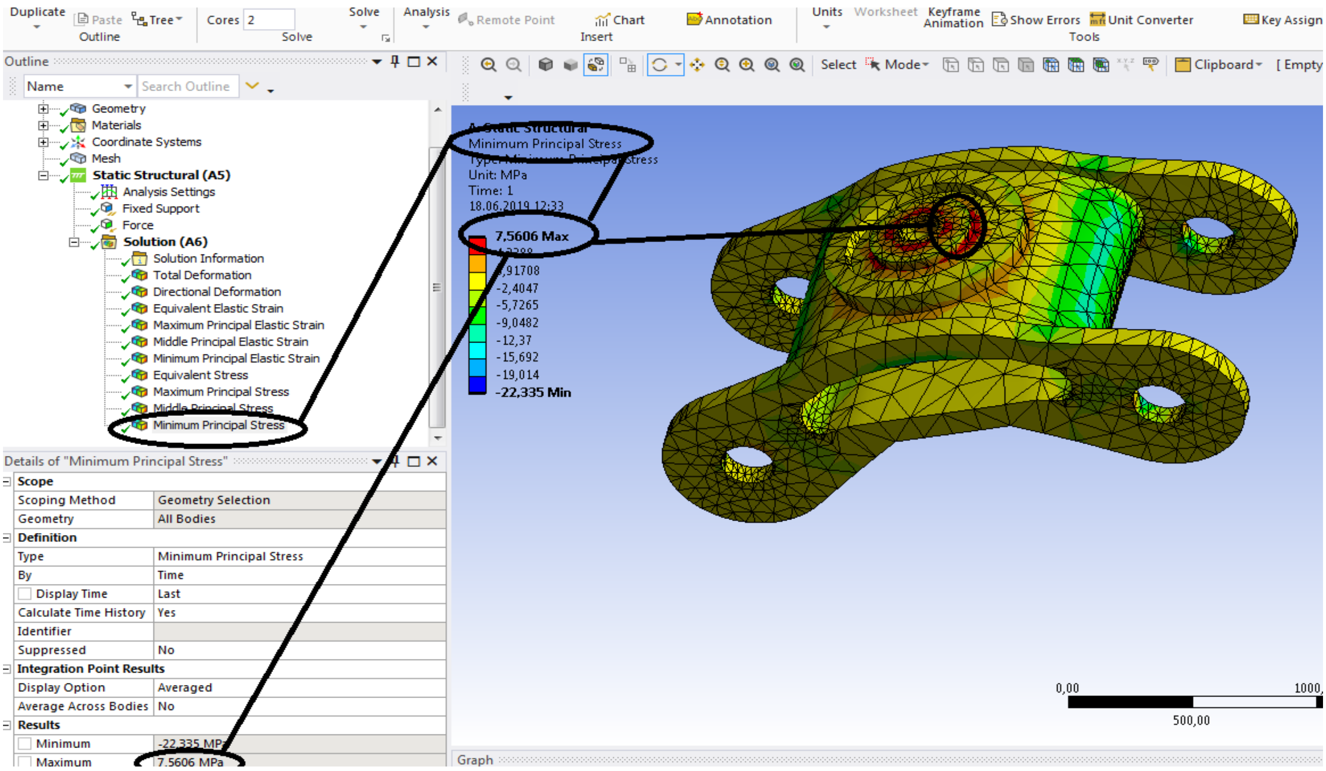


Figura 33-Tensiunile principale $\sigma 3$ [MPa

1.3 Static structural termic boghiu

Se deschide Ansys Workbench;

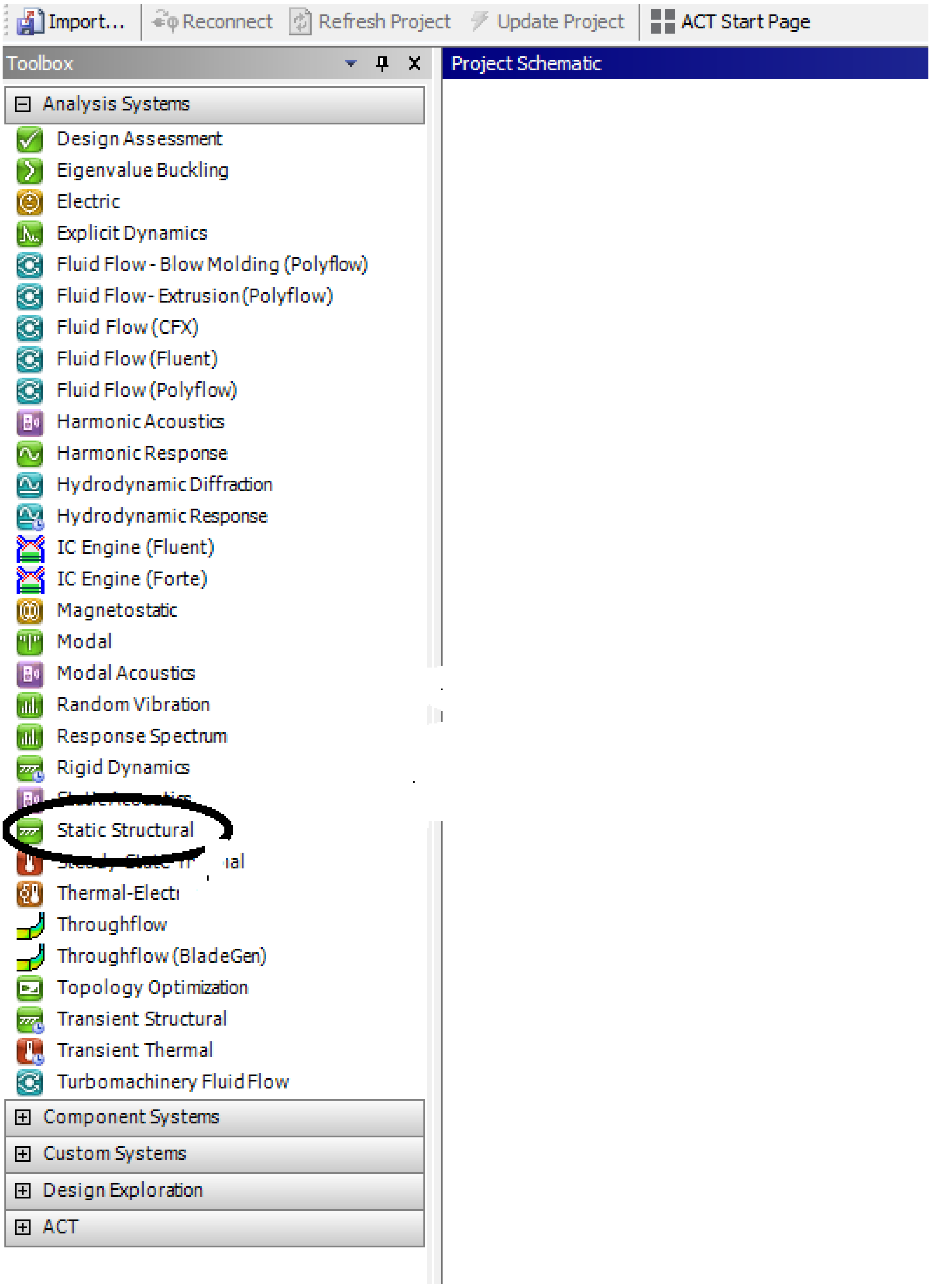


Figura 34 -Se deschide Ansys Workbench

Se da dublu clic dreapta pe static structural si apare casuta din stanga;

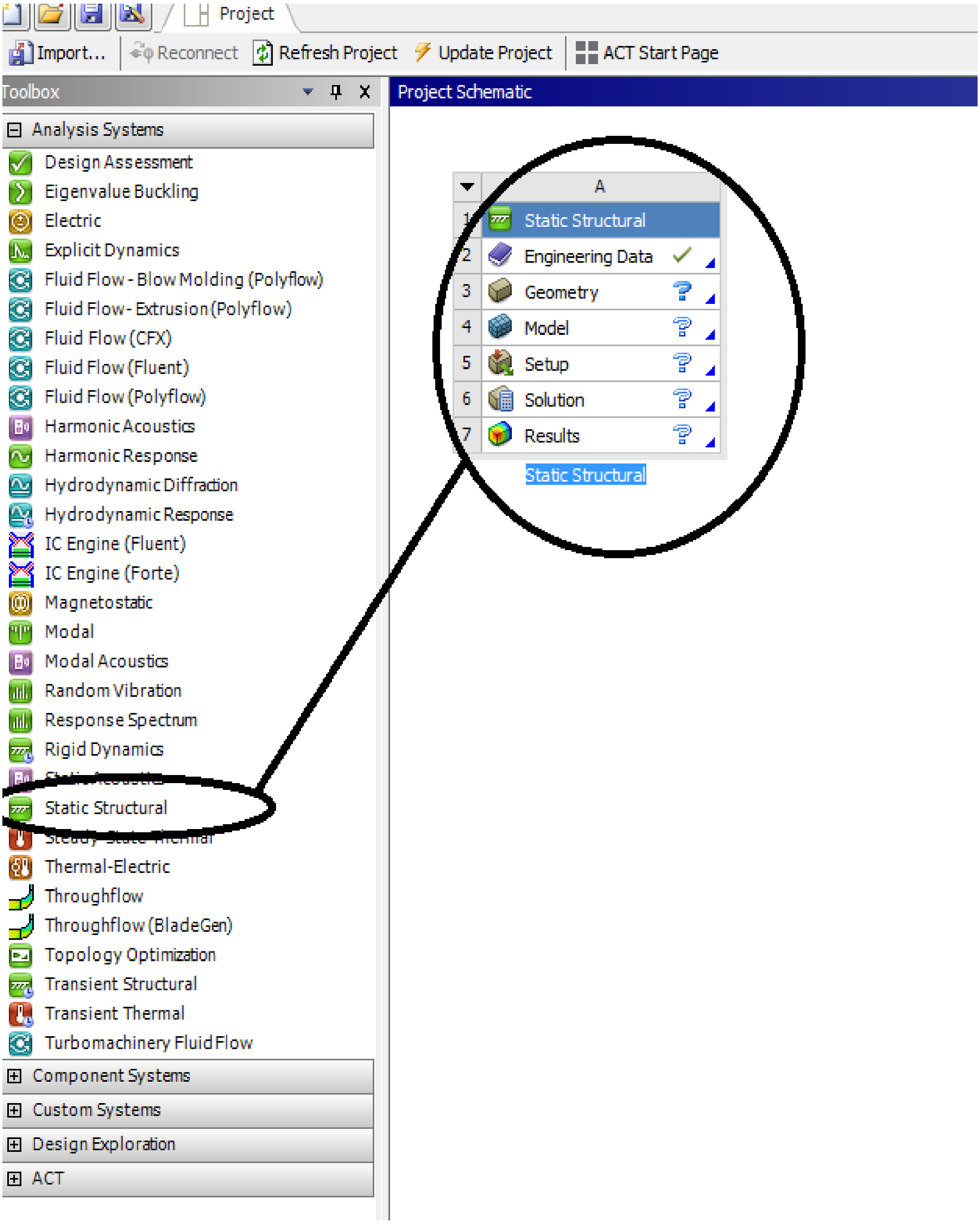


Figura 35- Se deschide Ansys Workbench- Static Strctural dreapta- Static Strctural dreapta-A (stanga)

Se selecteaza Geometry din stanga si se da un clic dreapta- Import Geometry-Browse ;

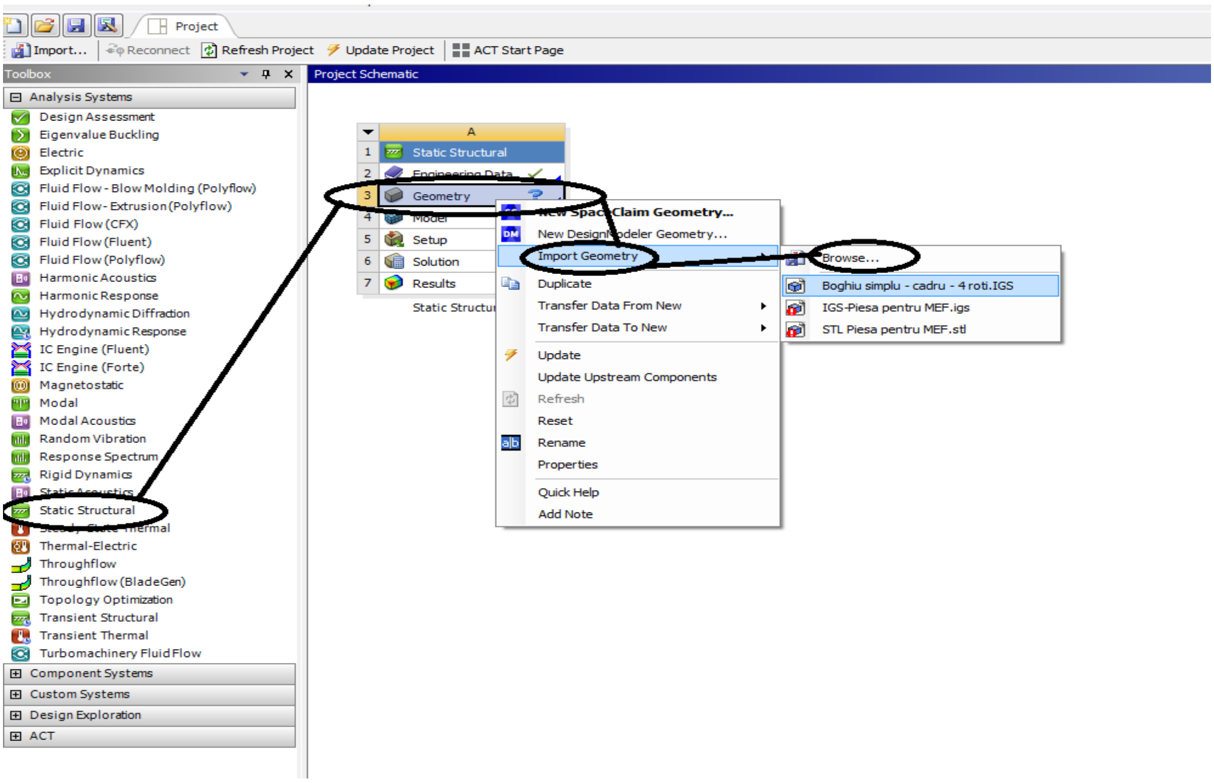


Figura 36- Se deschide Ansys Workbench- Static Strctural dreapta- Static Strctural dreapta-A (stanga) - Import Geometry-Browse

Se selecteaza Geometry din stanga si se da un clic dreapta- Import Geometry-Browse- se da clic dreapta pe Browse si aleg directorul din Desktop unde se afla desenul in formatele : IGS, SAT etc.

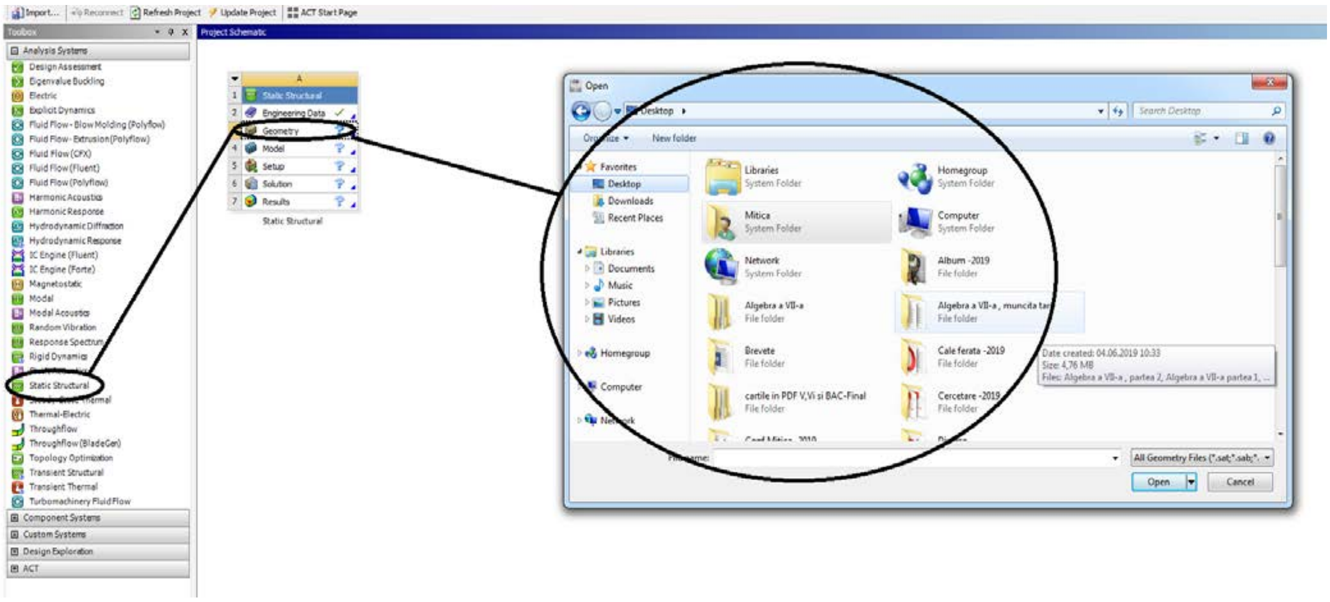


Figura 37- Se deschide Ansys Workbench- Static Strctural dreapta- Static Strctural dreapta-A (stanga) - Import Geometry-Browse-Directorul unde este geometria

Se selecteaza Geometry din stanga si se da un clic dreapta- Import Geometry-Browse- se da clic dreapta pe Browse si aleg directorul din Desktop unde se afla desenul in formatele : IGS, SAT etc.

In acest caz exista boghiul in format IGS si se da OPEN

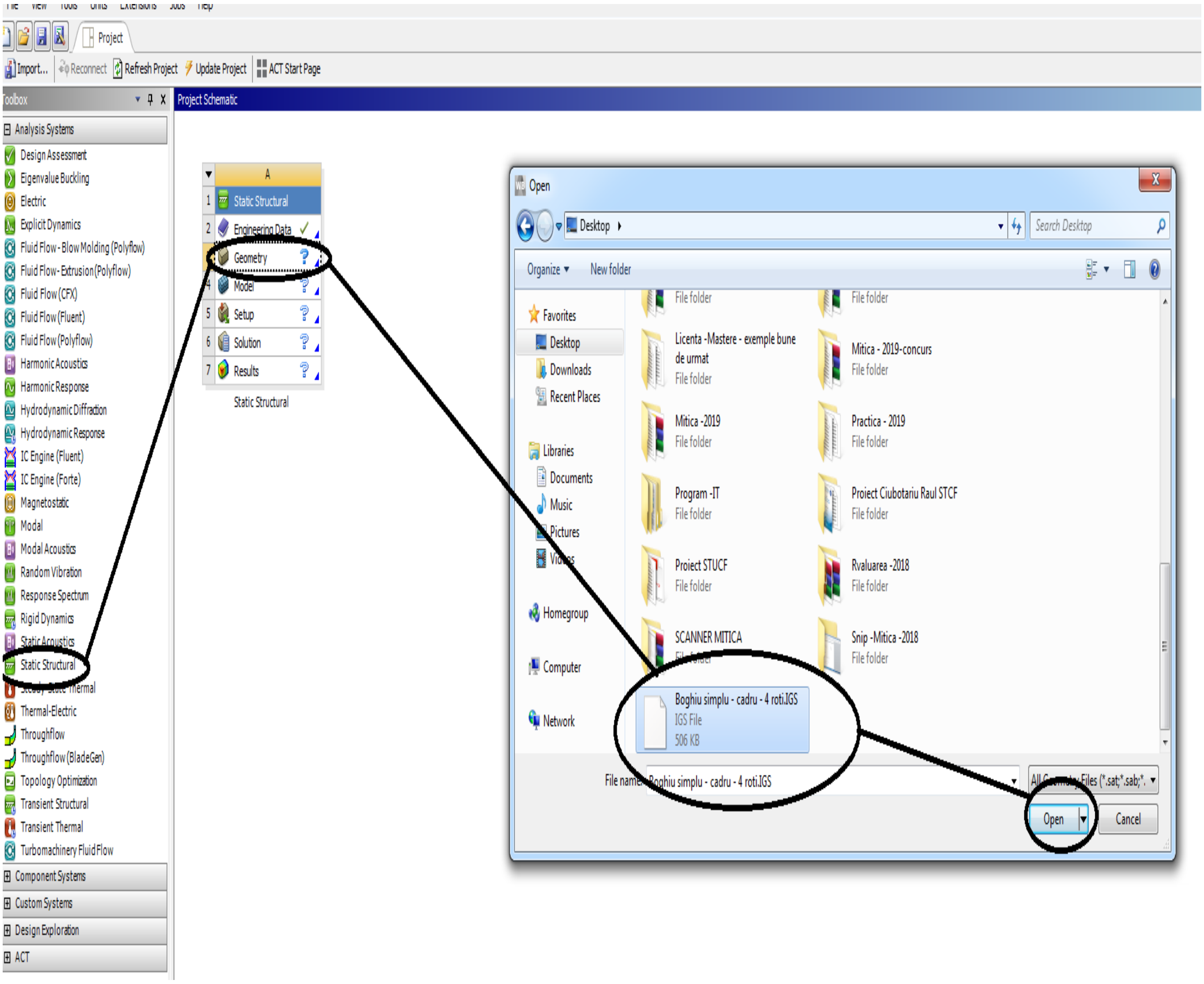


Figura 38- Se deschide Ansys Workbench- Static Strctural dreapta- Static Strctural dreapta-A (stanga) - Import Geometry-Browse-Directorul unde este geometria- se selecteaza geometria si se da Open

Se selecteaza Geometry din stanga si se da un clic dreapta- Import Geometry-Browse- se da clic dreapta pe Browse si aleg directorul din Desktop unde se afla desenul in formatele : IGS, SAT etc.

In acest caz exista boghiul in format IGS si se da OPEN si la Geometry trebuie sa apara semnul verde pentru a trece mai departe.

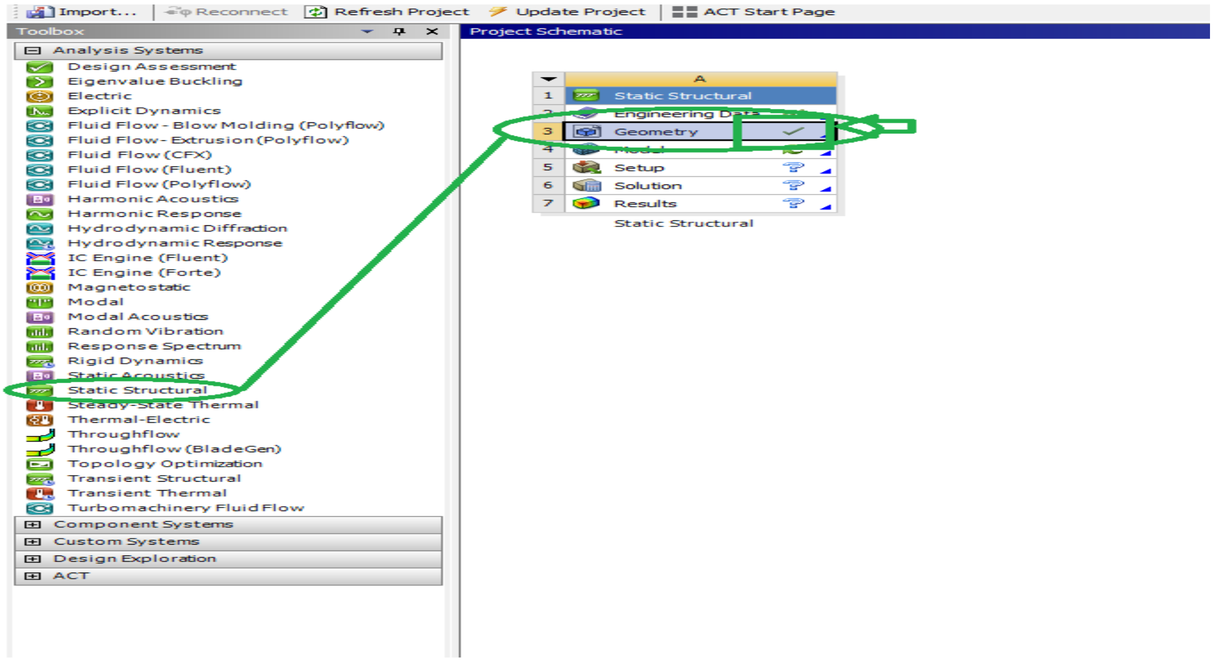


Figura 39- Se deschide Ansys Workbench- Static Strctural dreapta- Static Strctural dreapta-A (stanga) - Import Geometry-Browse-Directorul unde este geometria- se selecteaza geometria si se da Open- Geometria este in Ansyis

Se da dublu clic pe Model din casuta din stanga ;

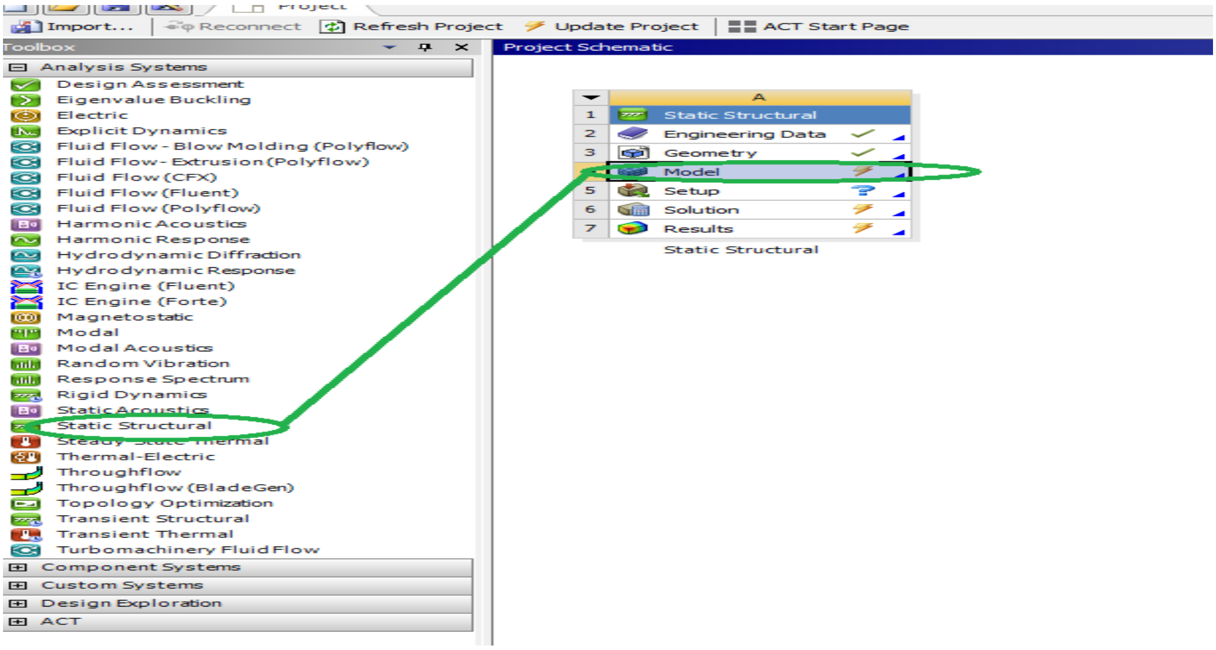


Figura 40- Se deschide Ansys Workbench- Static Strctural dreapta- Static Strctural dreapta-A (stanga) - Model

Apare Project

- **Toate rezolvate sunt cu vazut de culoare verde, daca sunt probleme se arata culoarea galbena sa semnul intrebarii;**

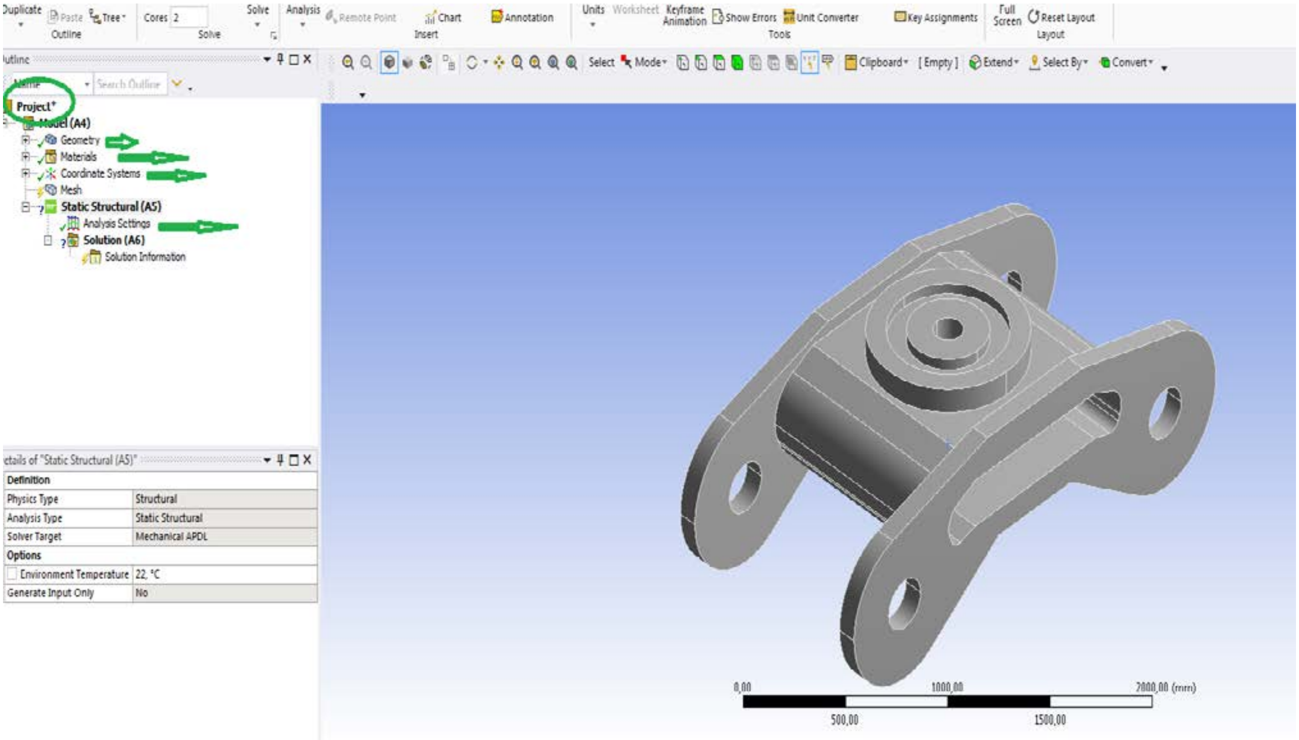


Figura 41- Ansys Workbench deschis -Pagina de lucru

Se discretizeaza boghiu, pentru asta se da clic pe mesch , apoi la generate mech clic dreapta si se face discretizarea grosolana

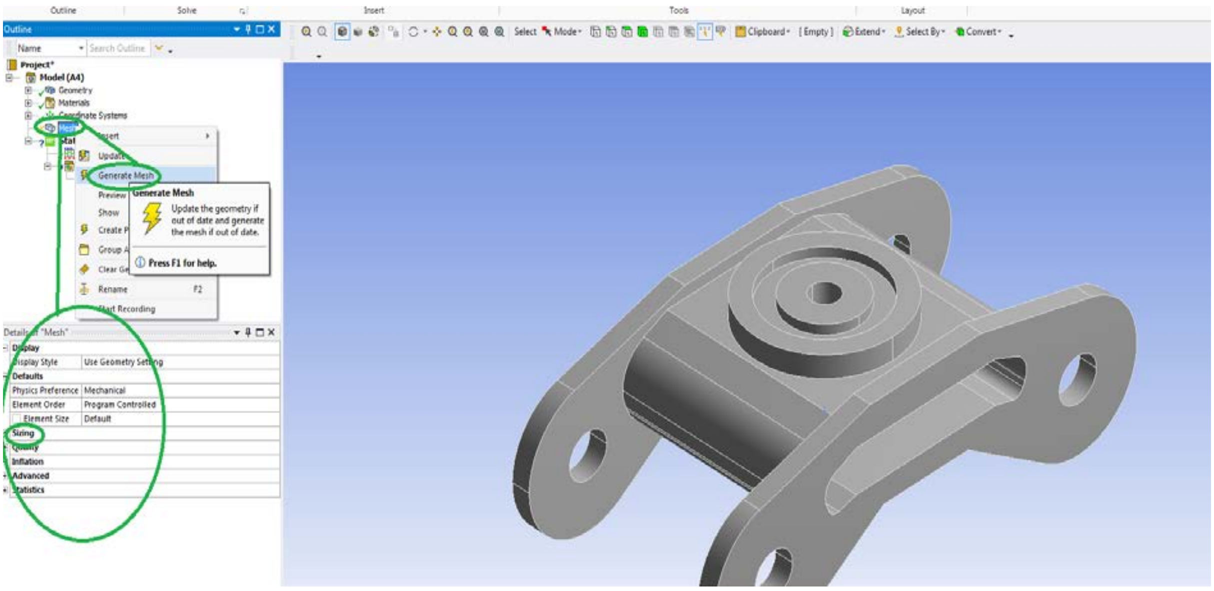


Figura 42-Project –Model (A4) – Mesch – Generate Mesch- Diesretizarea grosolana

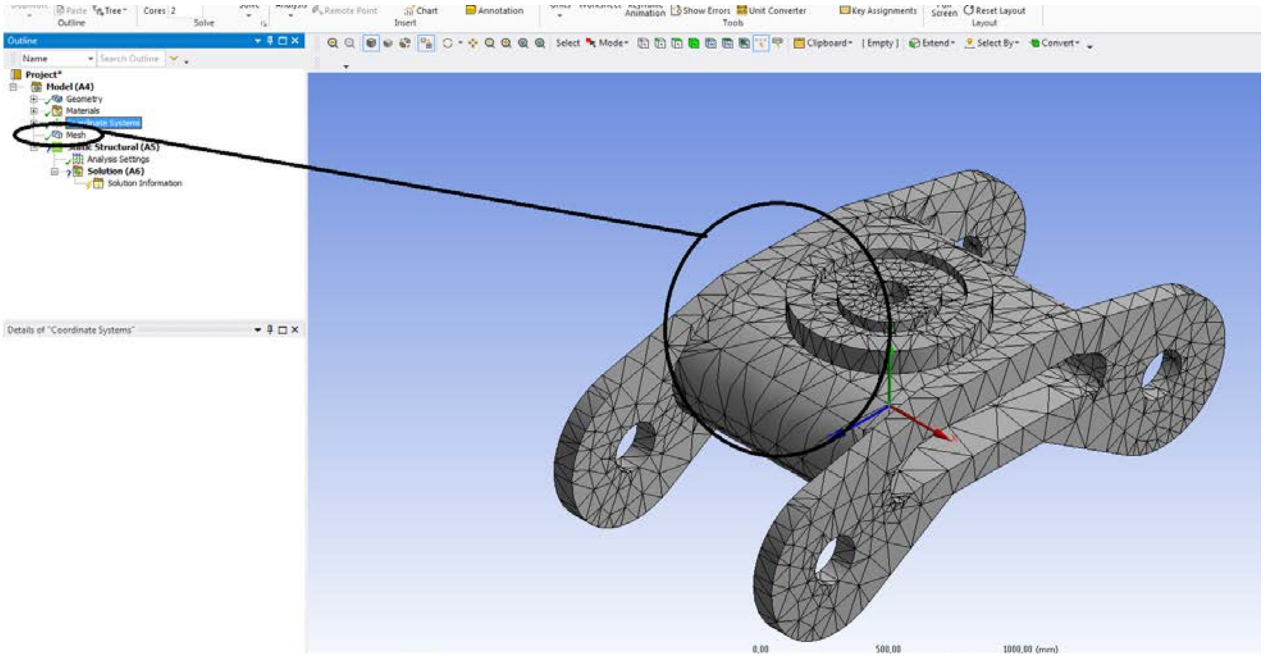


Figura 43- Project –Model (A4) – Mesch – Generate Mesch- Detail Mesch- Discretizare fina

1.1 Static structural mecanic pentru boghiul vagonului de cale ferata

Se trece la Static structural

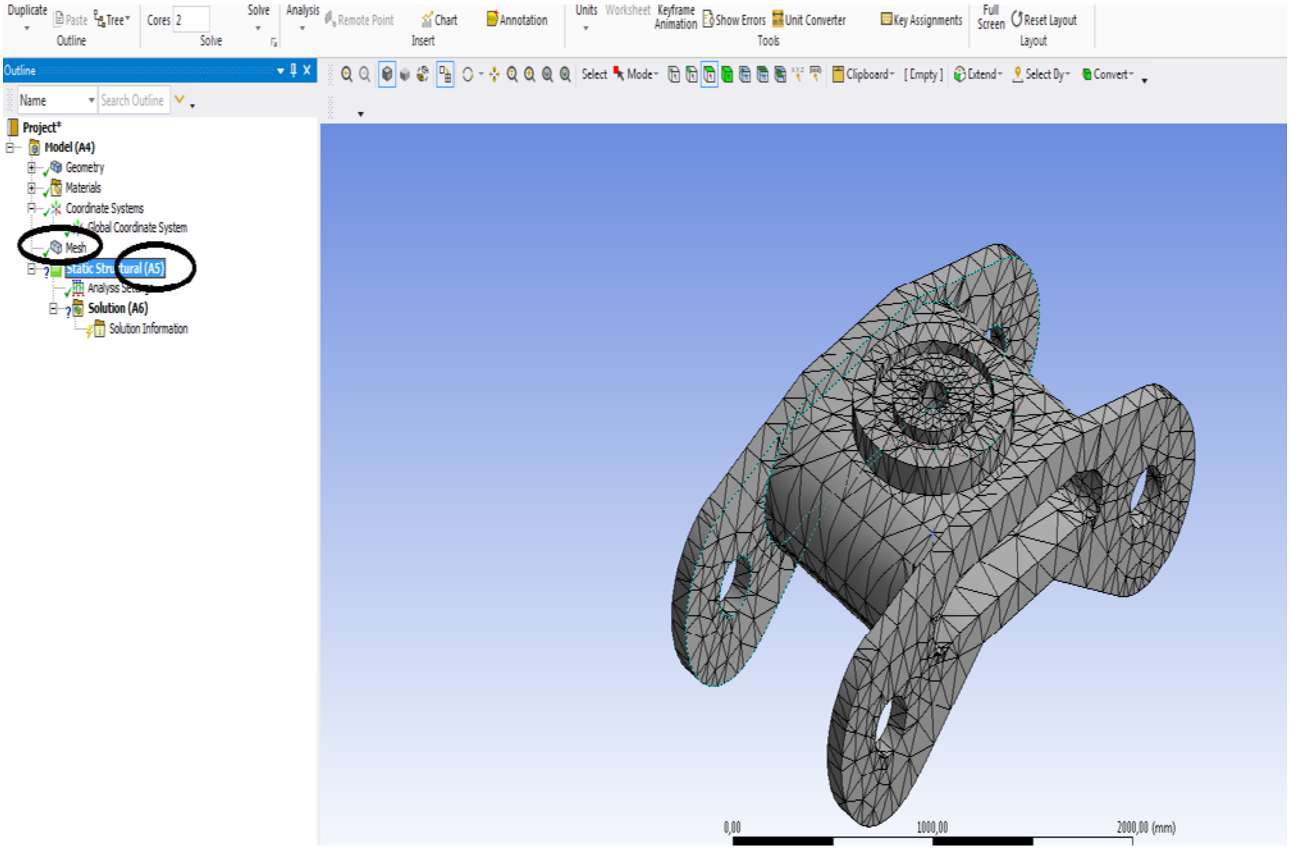


Figura 44- Project –Model (A4) –Static Structural (A5)

La Static Dtructural se alege suprafetele cu paralelipipedul de sus, apoi cu CTRL apsat se selecteaza suprafetele boghiului (sunt patru suprafete)

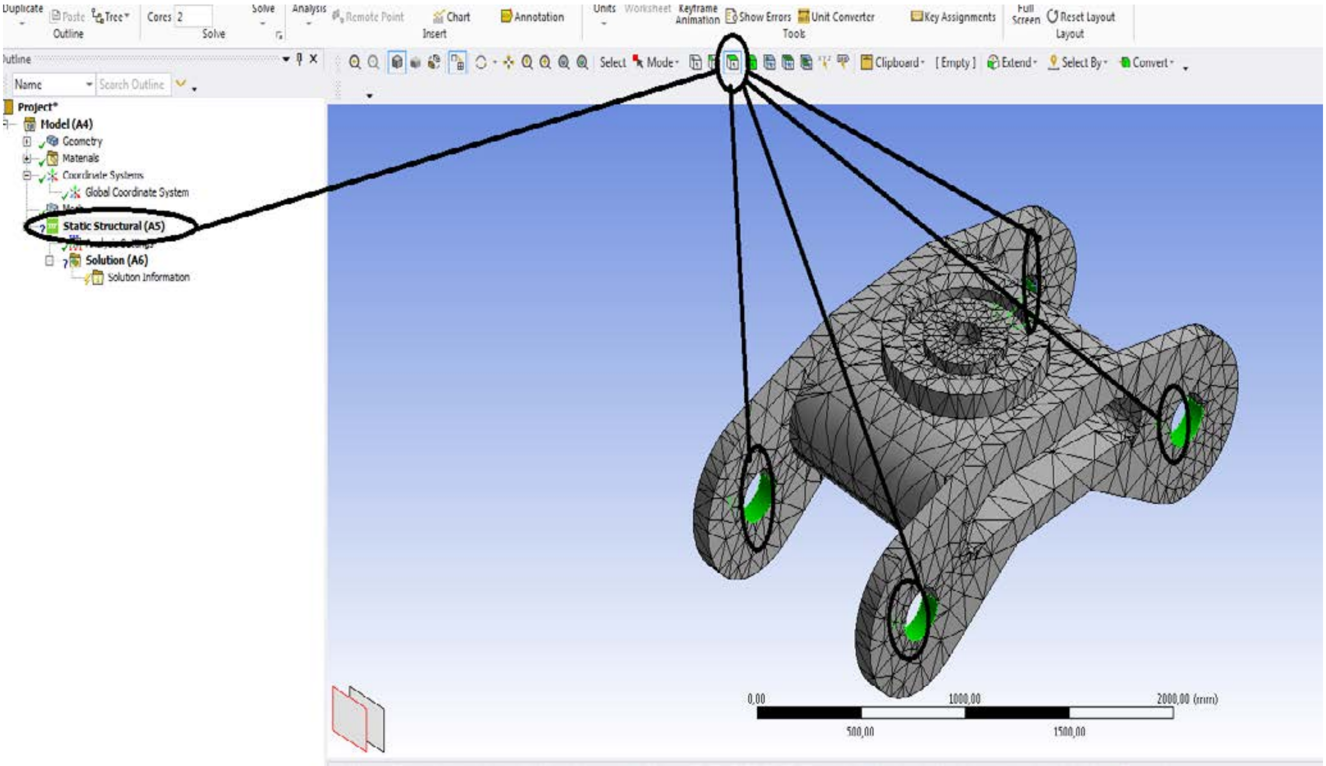


Figura 45- Project –Model (A4) –Static Structural (A5)- Selectarea suprafetelor de reazem

Clic dreapta pe Static Structural – Insert-Fixed Support

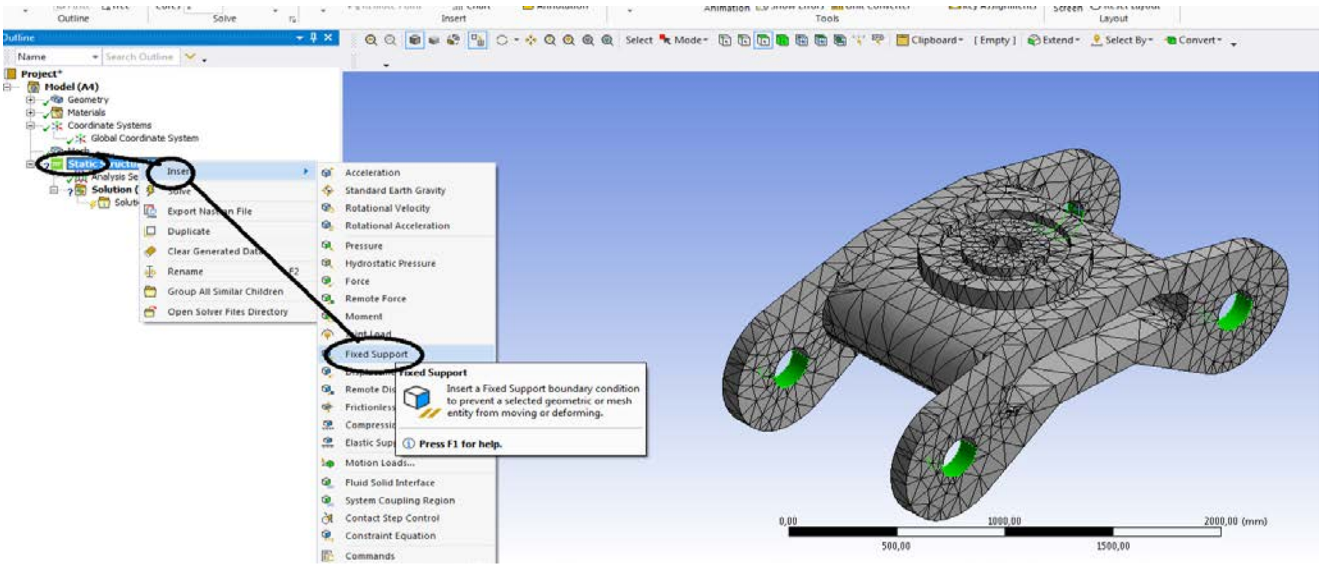


Figura 46- Project –Model (A4) –Static Structural (A5)- Insert-Fixed Support

Clic dreapta pe Static Structural – Insert-Fixed Support-clic dreapta pe Fixed Support si apare liniuta de bifat verde (este bun asa)

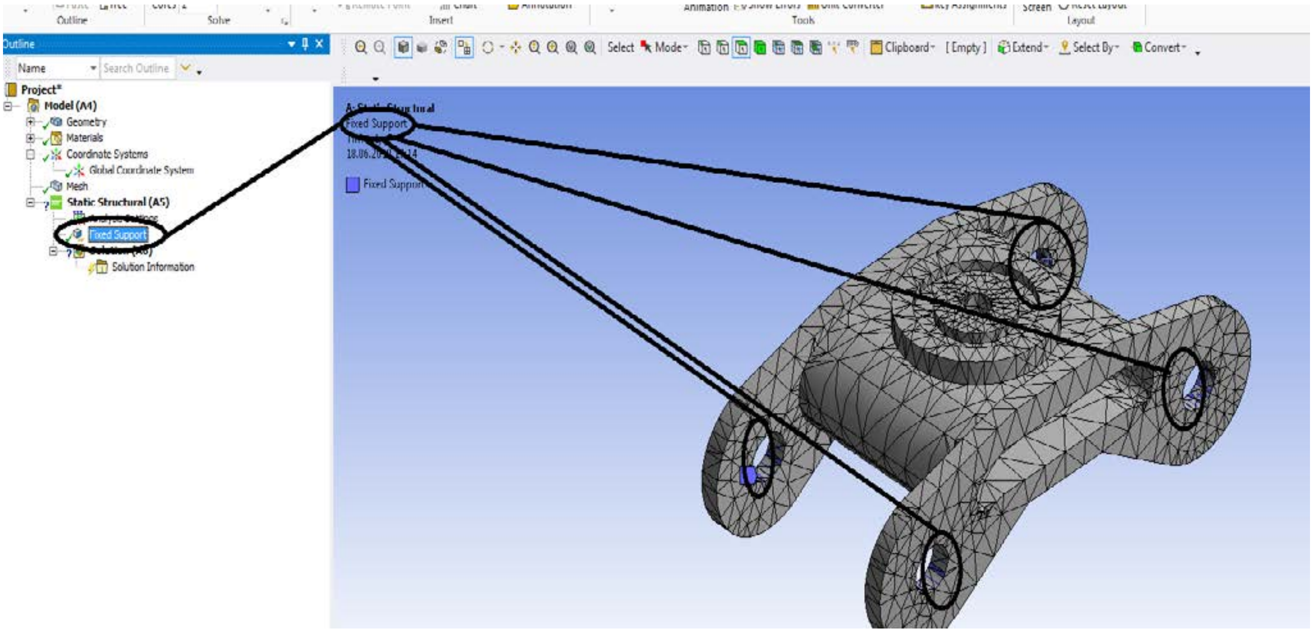


Figura 47- Project –Model (A4) –Static Structural (A5)- Insert-Fixed Support- clic dupa ce sau selectat suprafete de reazem

1.2 Static Structural termic – Boghiu de vagon cale ferata

- **Se selecteaza de sus cubul plin , apoi se da clic pe boghiu si se face verde tot;**

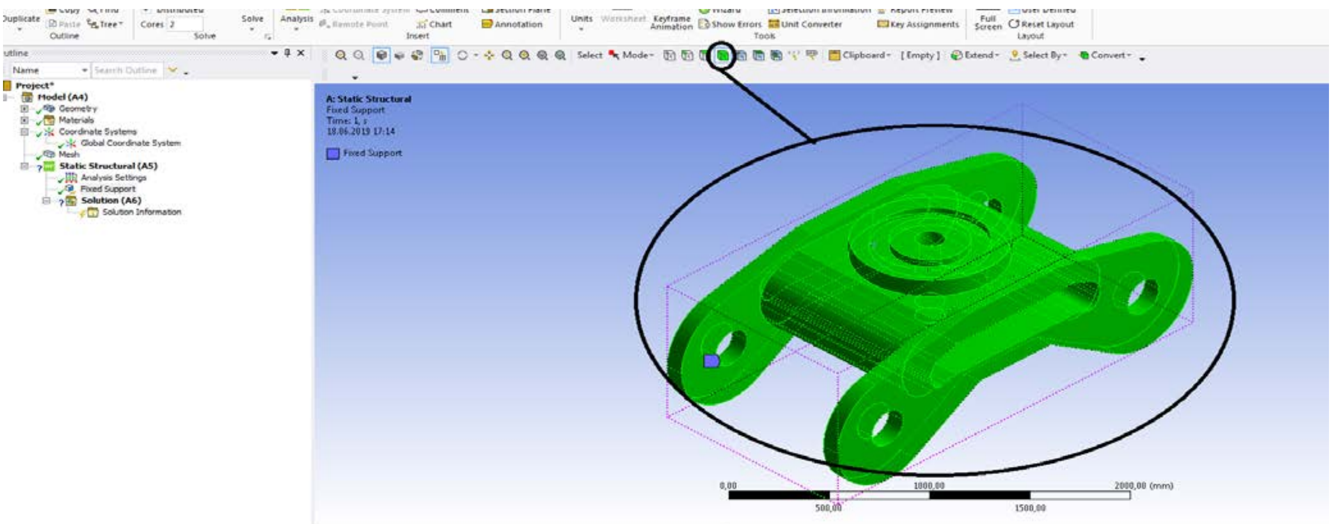


Figura 48- Project –Model (A4) –Static Structural (A5) –se selecteaza toata piesa in volum si Enter

Static Structural clic dreapta –Insert – Thermal Codition

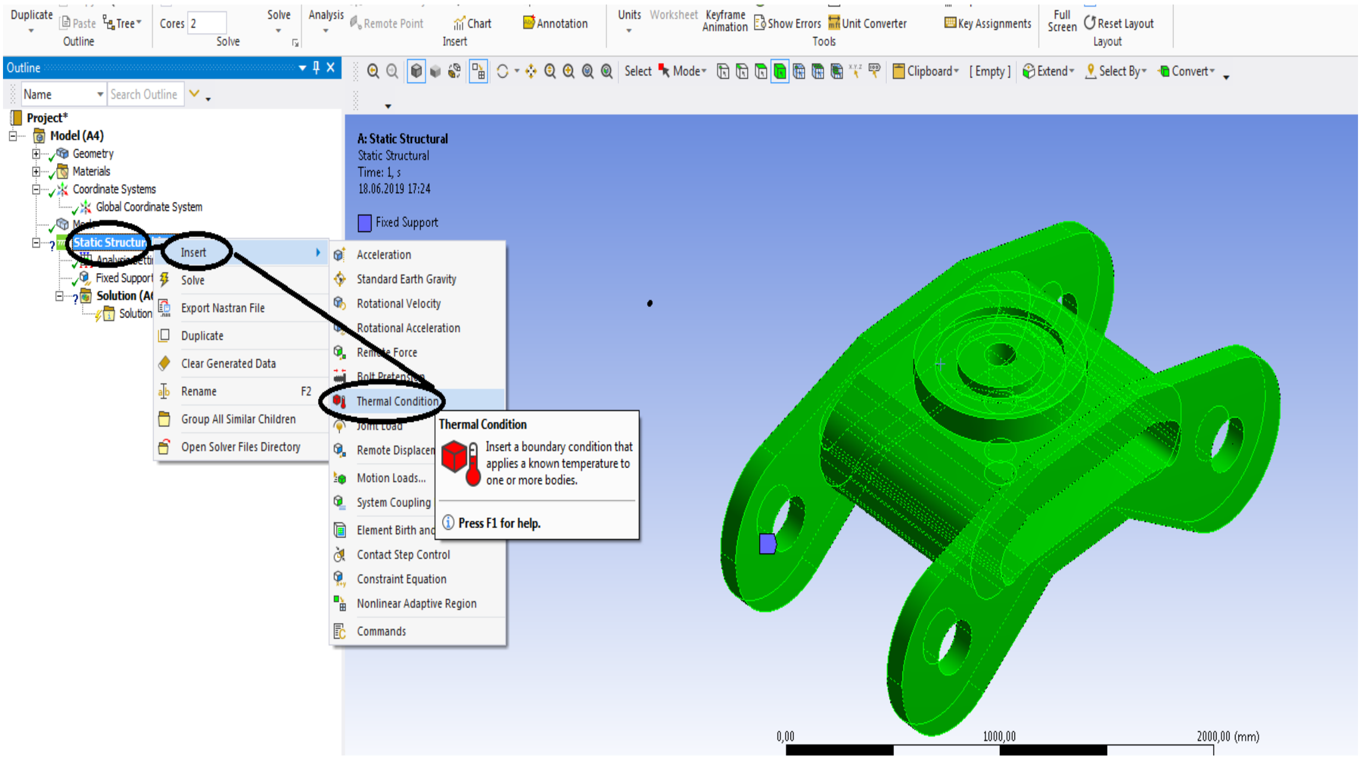


Figura 49- Project –Model (A4) -Static Structural clic dreapta –Insert – Thermal Codition

Static Structural clic dreapta –Insert – Thermal Codition- clic dreapta pe Thermal Codition (temperatura initiala este de 22 grade Celsius)

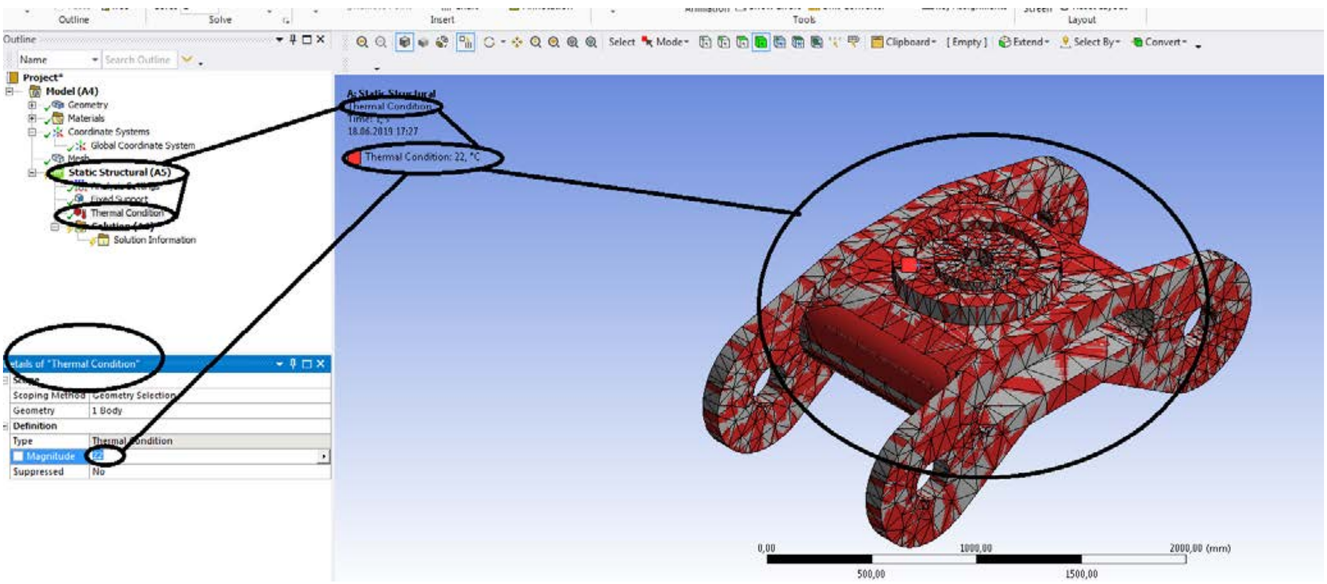


Figura 50- Project –Model (A4) -Static Structural clic dreapta –Insert – Thermal Codition- Temperatura se va schimba in casuta de jos de la Detail Temperature

Static Structural clic dreapta –Insert – Thermal Codition- clic dreapta pe Thermal Codition (temperatura initiala este de 22 grade Celsius), se schimba 22 de grade Celsius cu 100 grade Celsius , casuta din stanga jos

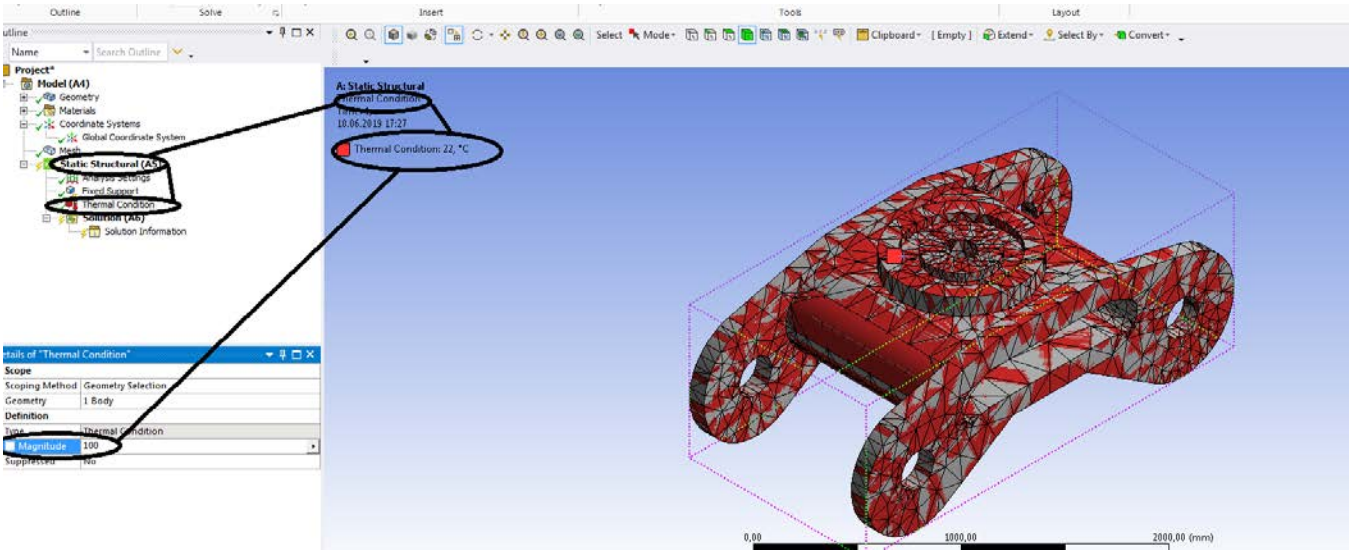


Figura 51- Project –Model (A4) -Static Structural clic dreapta –Insert – Thermal Codition- Temperatura se schimba in casuta de jos de la Detail Temperature T = 100 grade Celsius

Static Structural clic dreapta –Insert – Thermal Codition- clic dreapta pe Thermal Codition (temperatura initiala este de 22 grade Celsius), se schimba 22 de grade Celsius cu 100 grade Celsius , casuta din stanga jos – se apasa tasta Enter si ramane temperatura de incercare pentru boghiu de 100 de grade Celsius

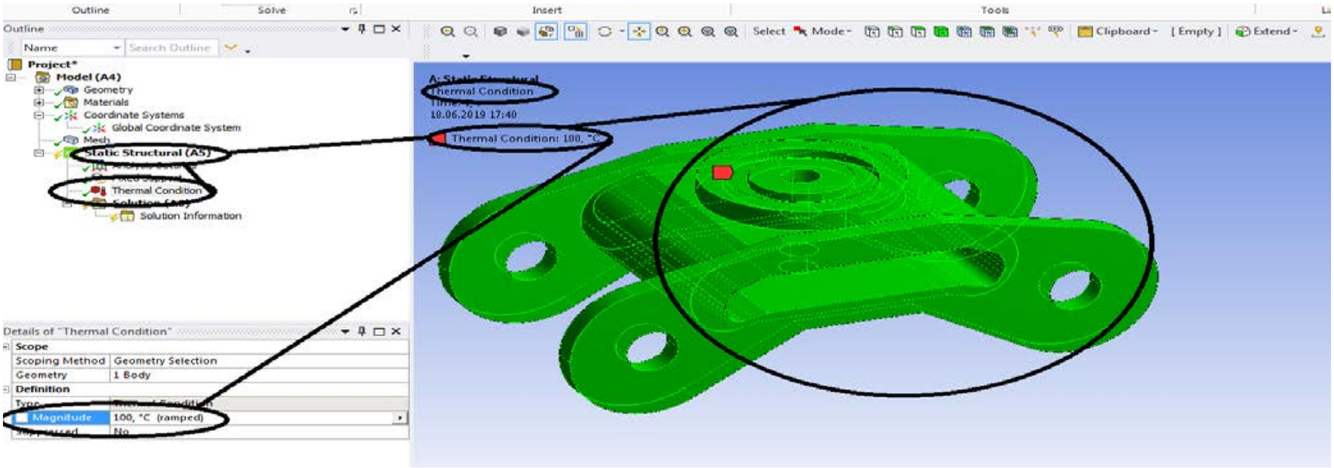


Figura 52- Project –Model (A4) -Static Structural -Temperature

Solution-A6

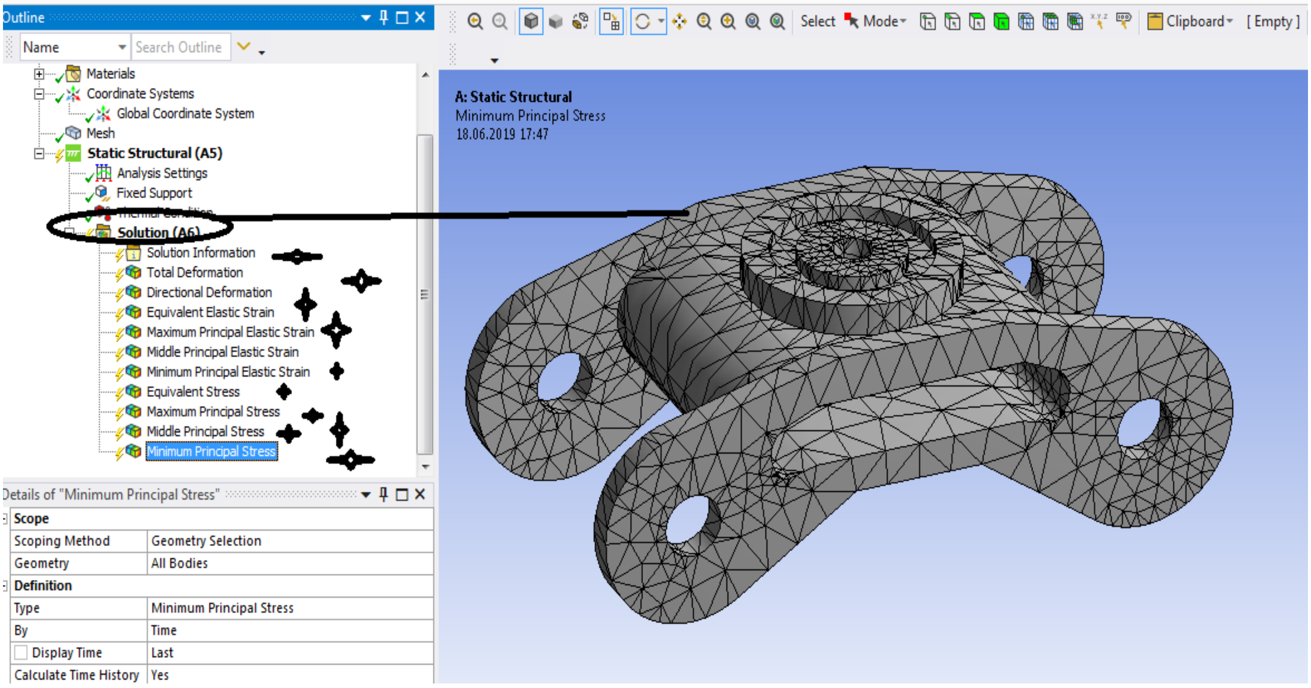


Figura 53- Project –Model (A4) -Static Structural (A5)-Solution A(6)-Solve

Dupa ce se da Solve se duce la Get Results si clic pe el si se obtin rezultatele finale

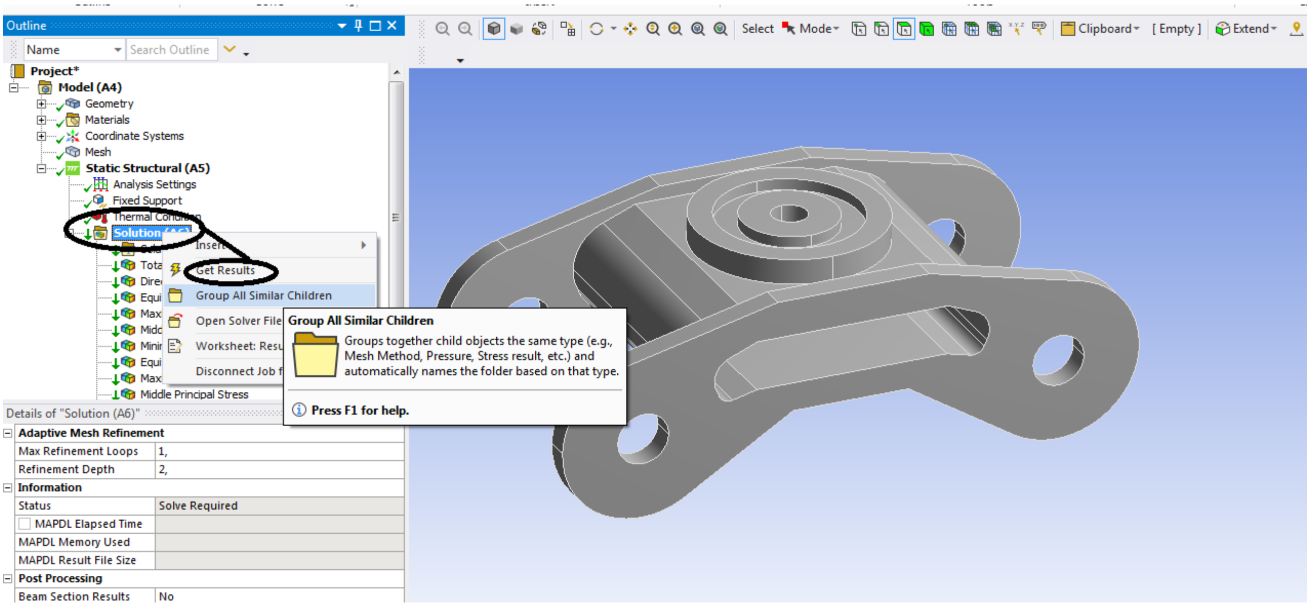


Figura 54- Project –Model (A4) -Static Structural (A5)-Solution A(6)-Get Results si clic

De la Solution toate au semnul bifat cu verde , solutia este buna.

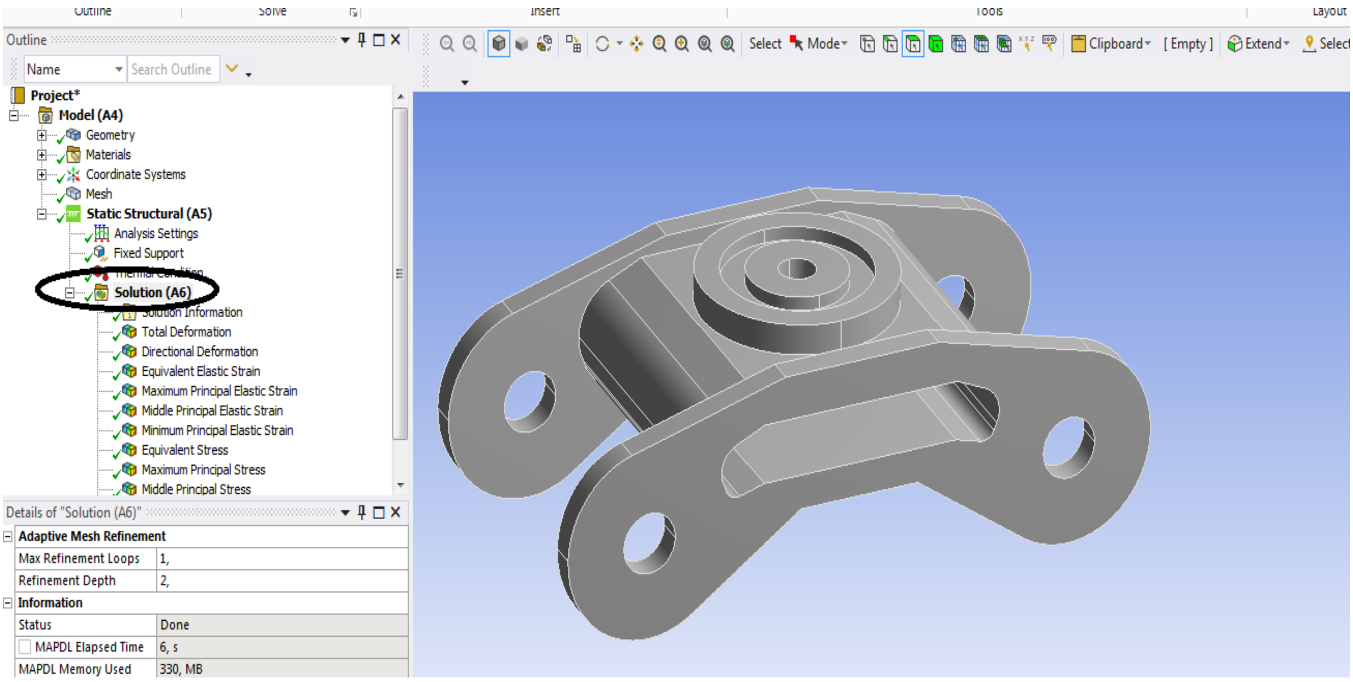


Figura 55- Project –Model (A4) -Static Structural (A5)-Solution A(6)-Get Results si clic-Rezultatele

1.4 Static structural termic boghiu - Rezultate

Tensiunea maxima echivalenta von Mises este de 982,57 Mpa, e prea mare si atunci modificam temperatura de incercare din 100 de grade Celsius se aplica 60 de grade Celsius.

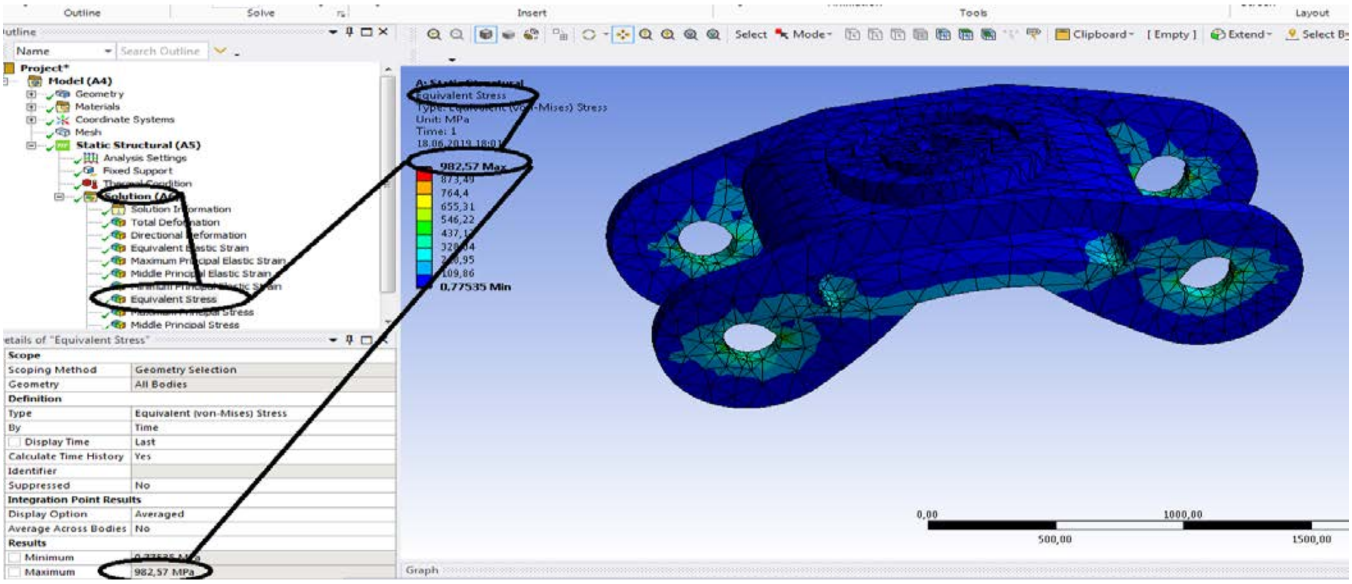


Figura 56- Project –Model (A4) -Static Structural (A5)-Solution (A6)-Tensiunea maxima echivalenta von Mises

Se schimba temperatura la 60 de gradeCelsius in casuta de stanga jos si se apasa tasta Enter

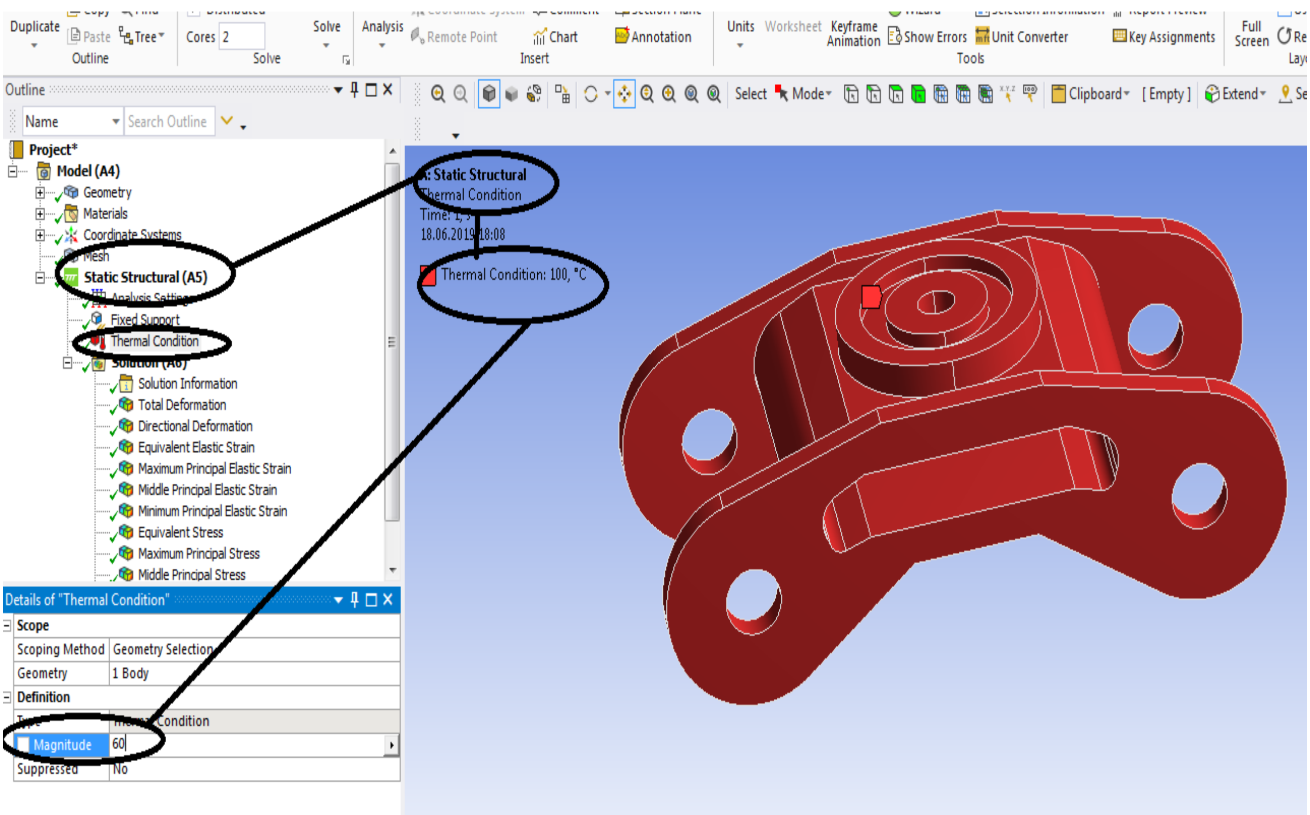


Figura 57- Project –Model (A4) -Static Structural (A5)-Temperatura se schimba

Rezultate

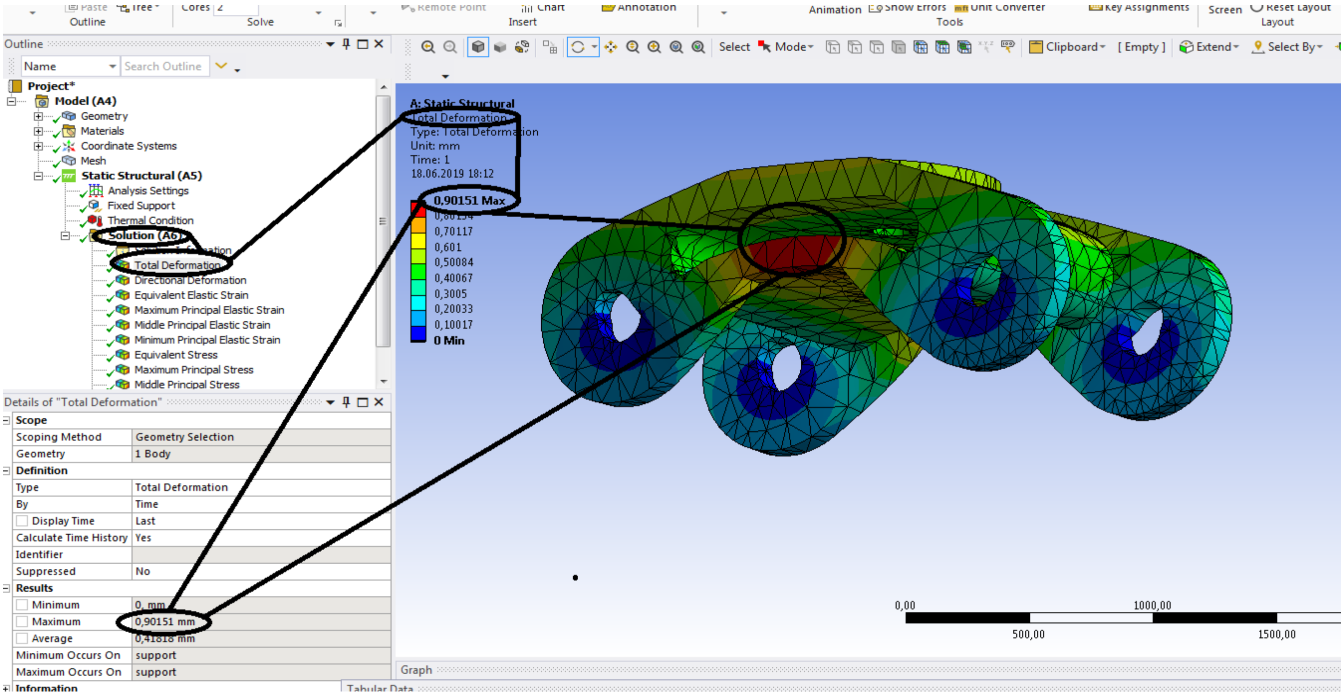


Figura 58- Deformații totale [mm]

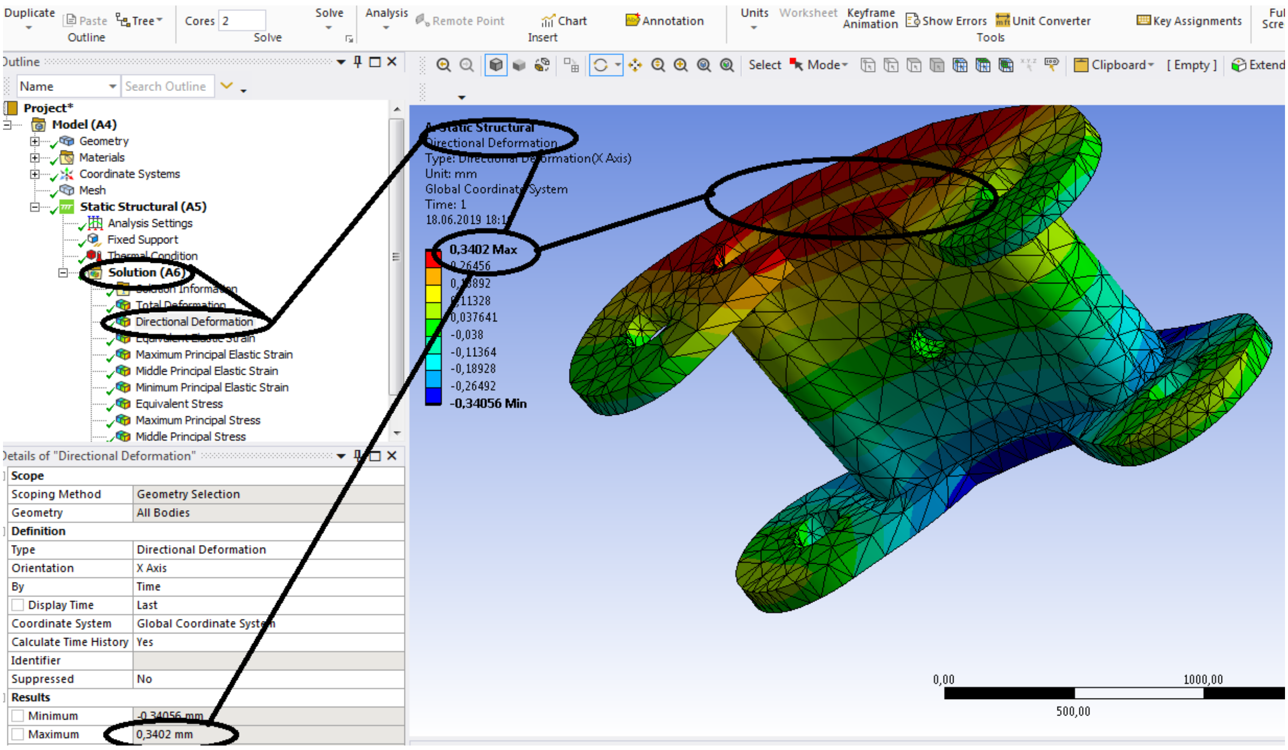


Figura 59 - Deformații direcționale pe axa x [mm]

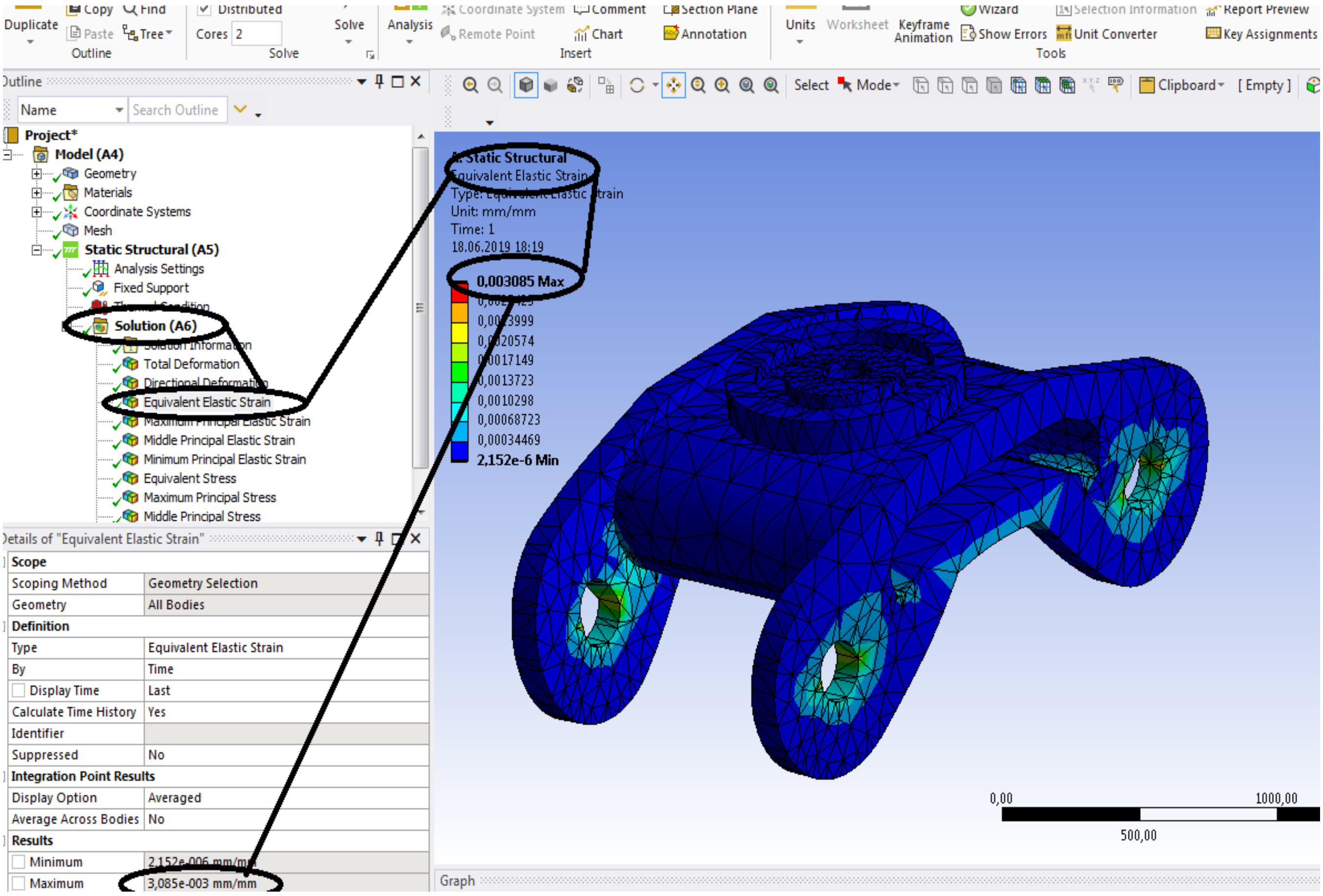


Figura 60 - Deformațiile specifice echivalente ε [mm/mm]

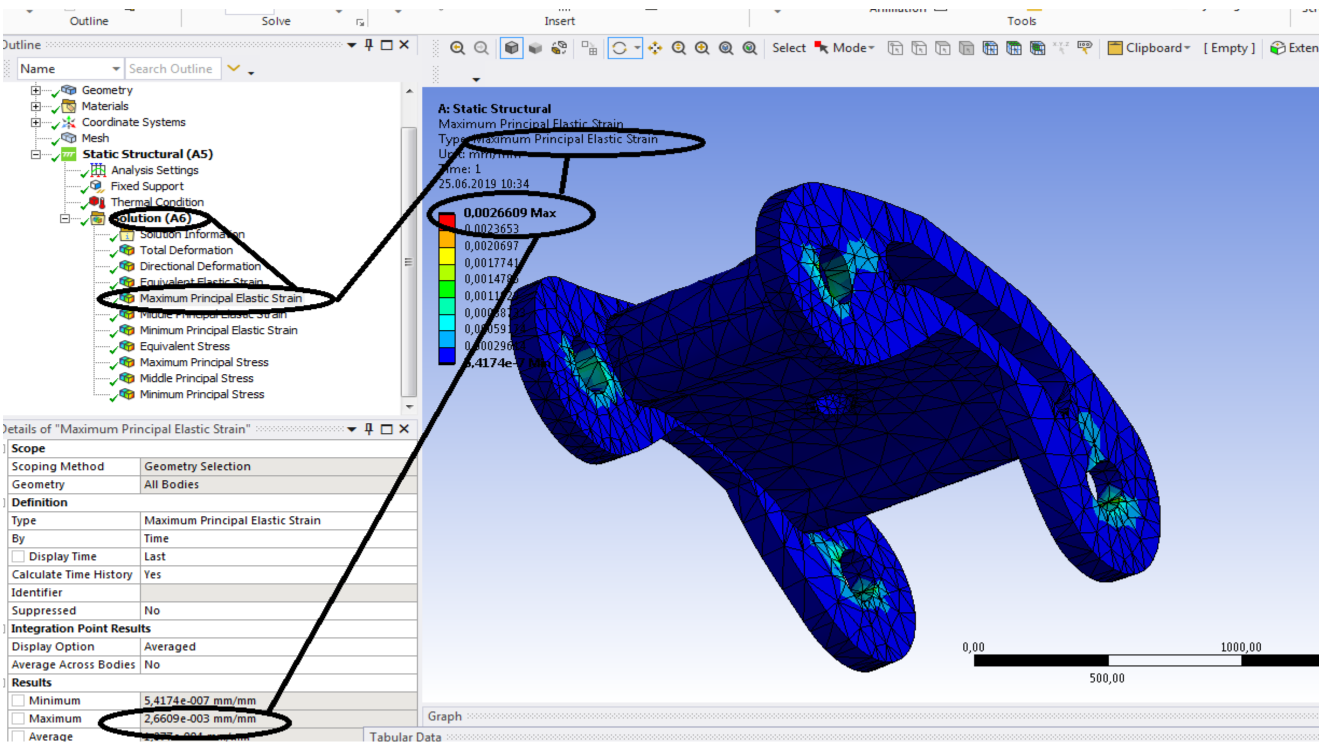


Figura 61 - Deformațiile specifice principale - ε1 [mm/mm]

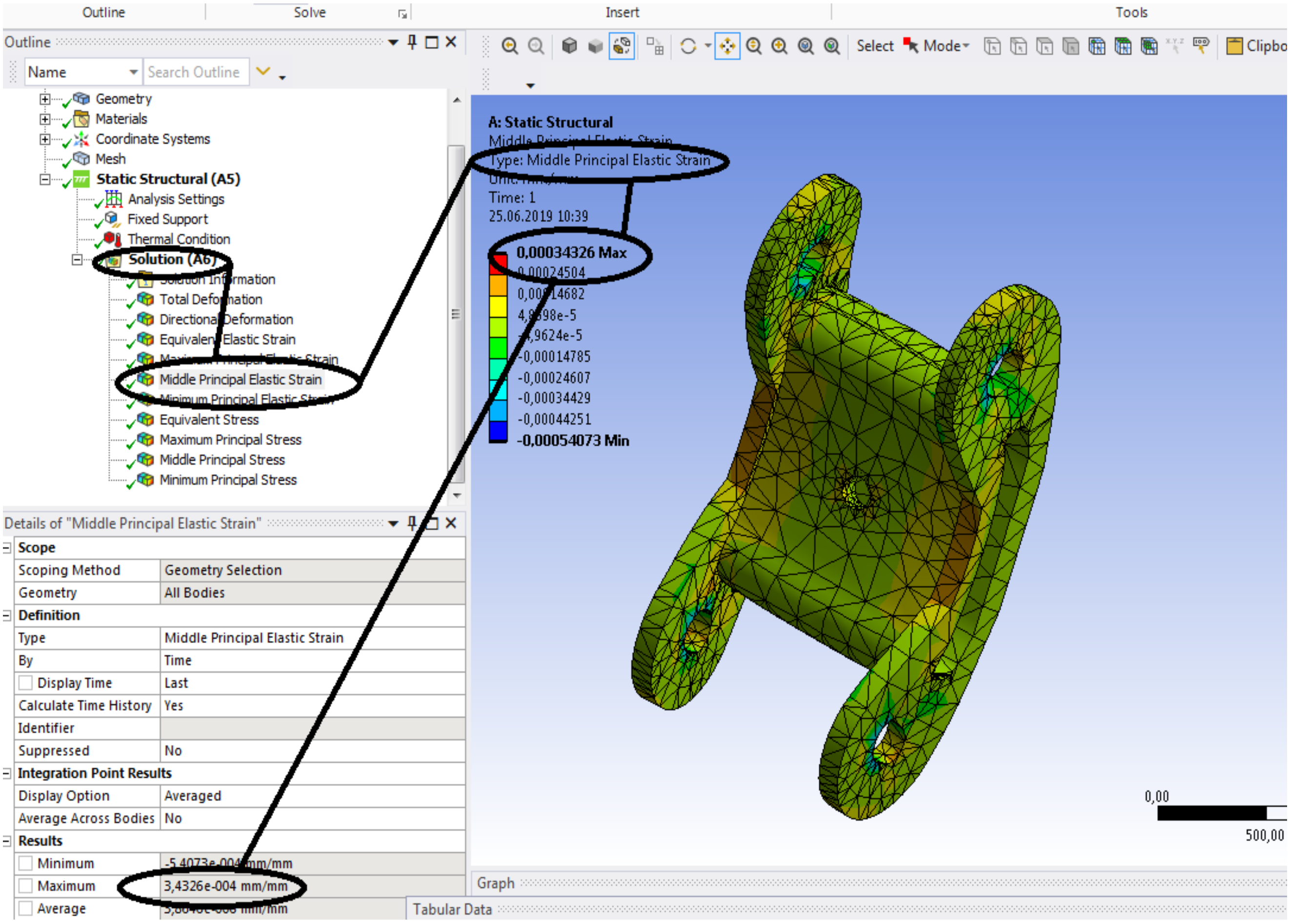


Figura 62- Deformațiile specifice principale ε2 [mm/mm]

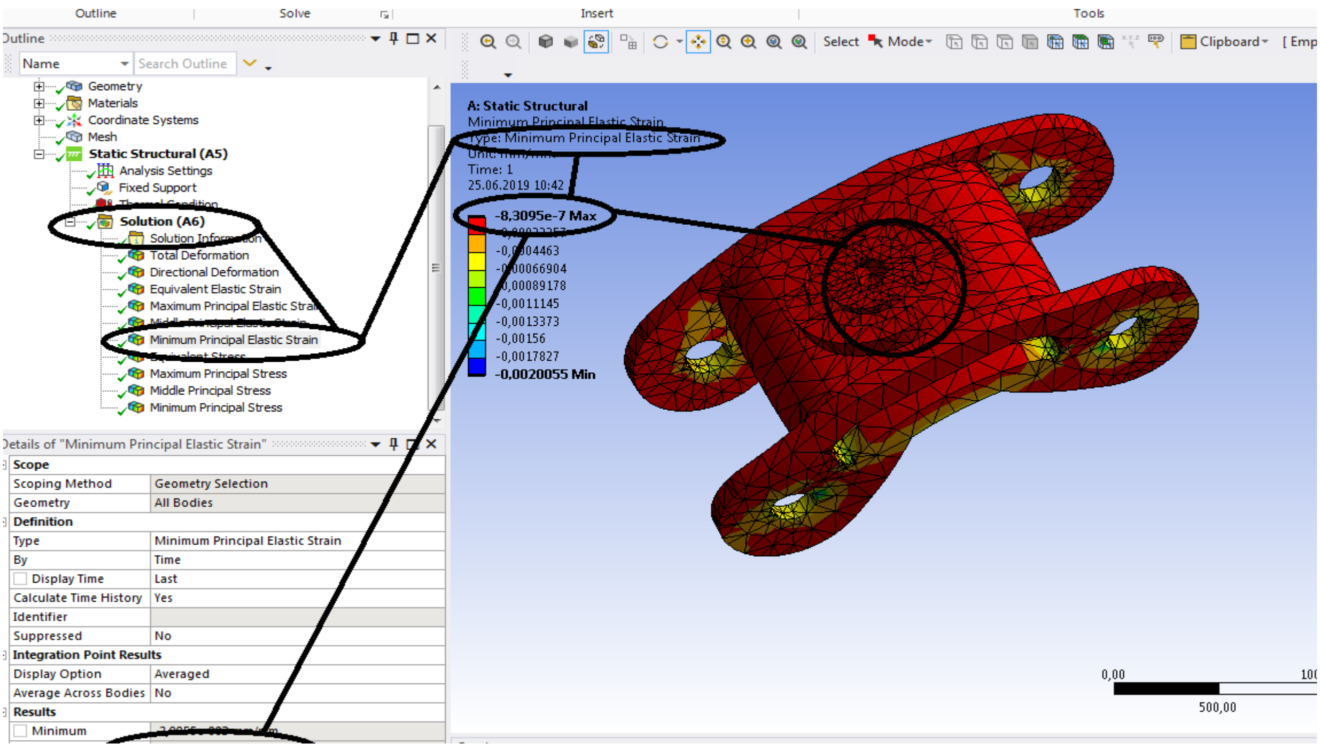


Figura 63 - Deformațiile specifice principale ε3 [mm/mm]

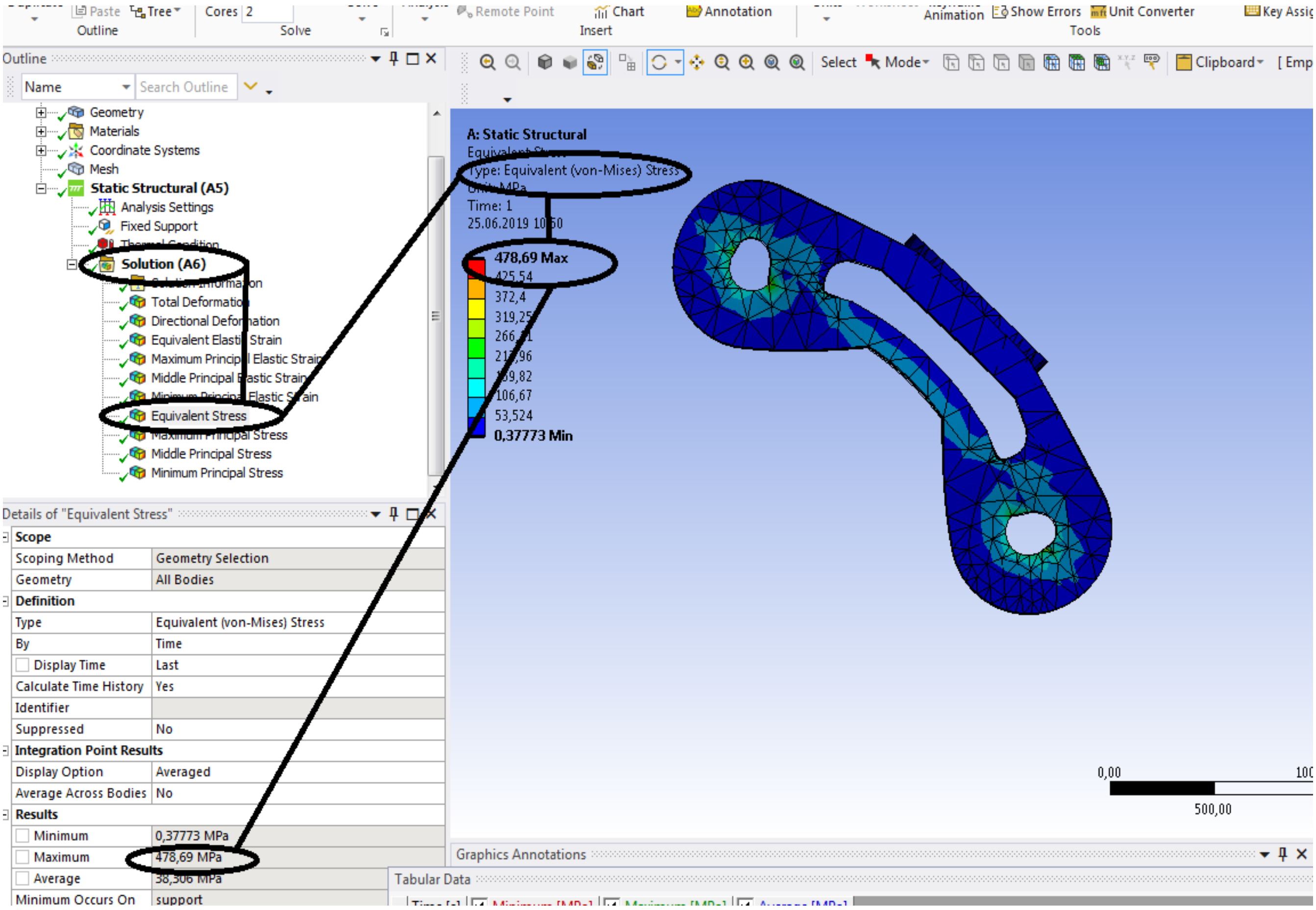


Figura 64 - Tensiunile echivalente von Mises [MPa]

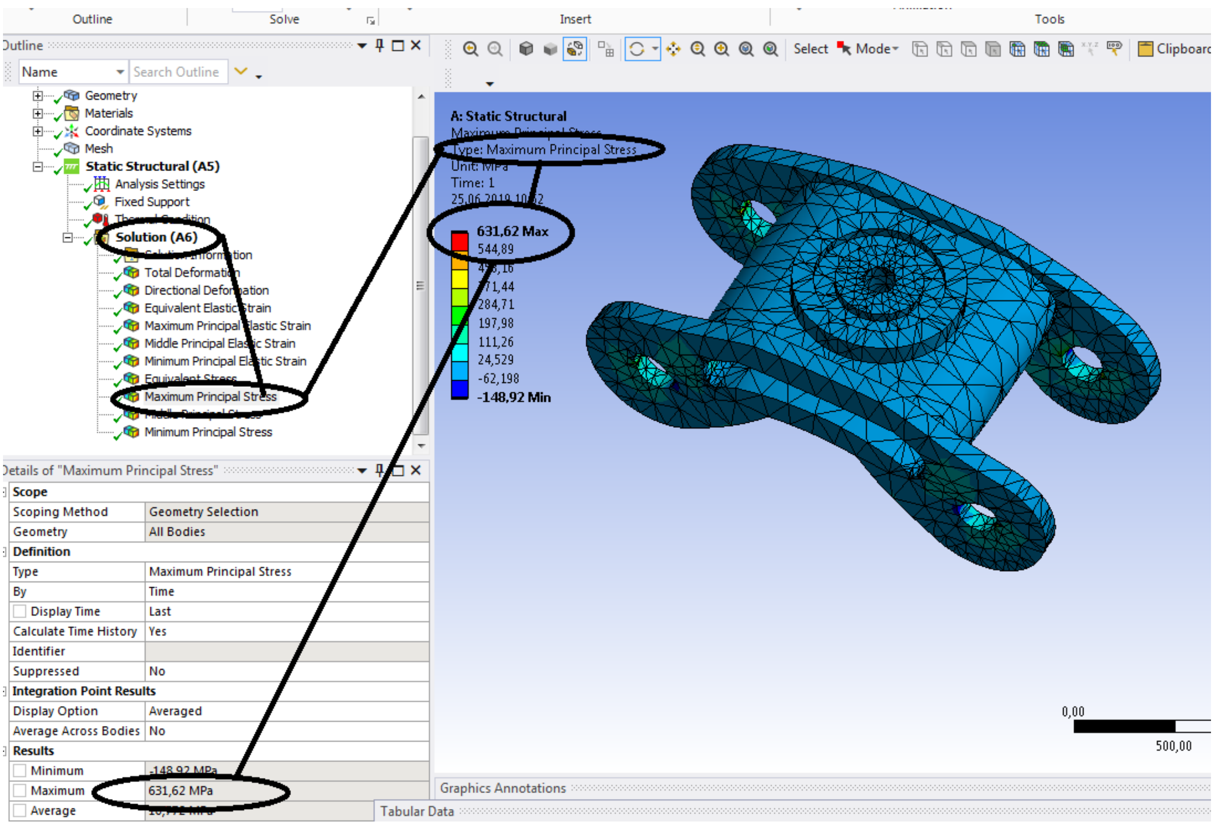


Figura 65 - Tensiunile principale $\sigma 1$ [MPa]

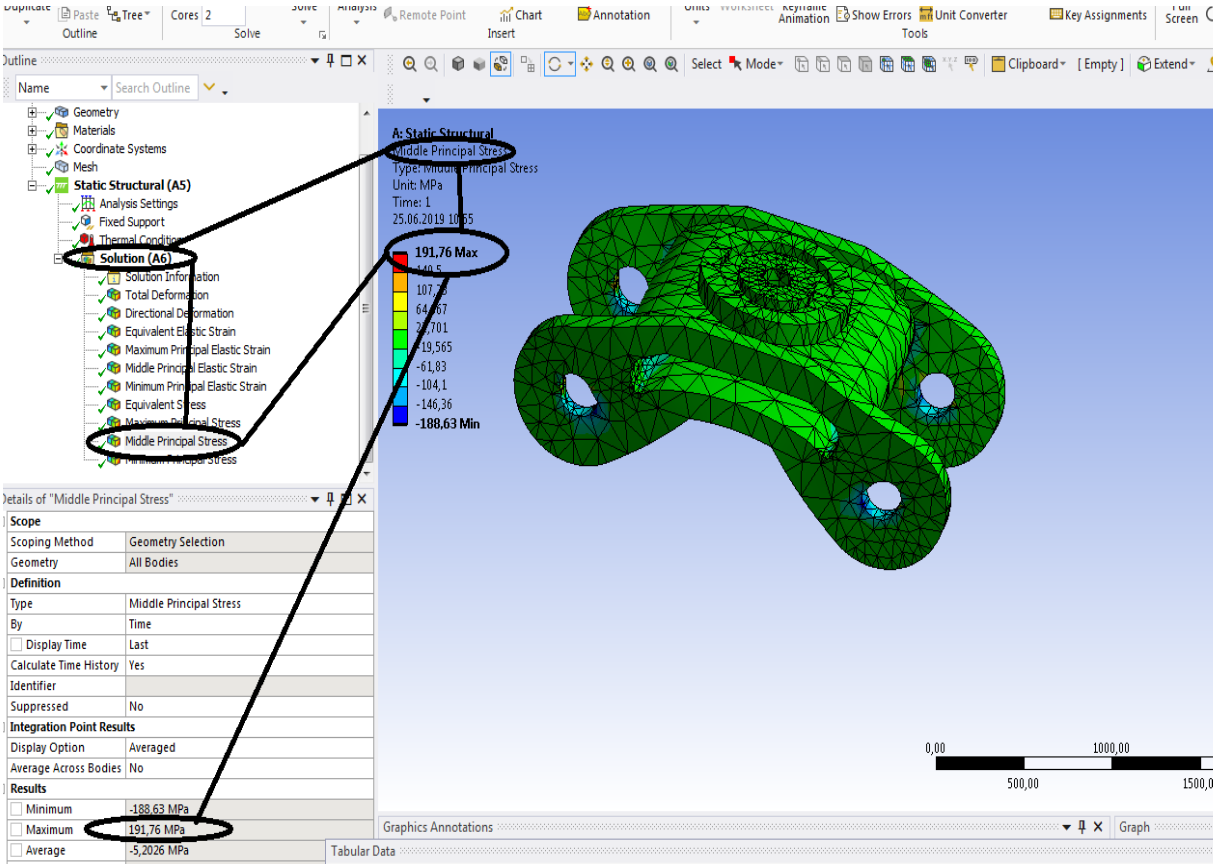


Figura 66 - Tensiunile principale $\sigma 2$ [MPa]

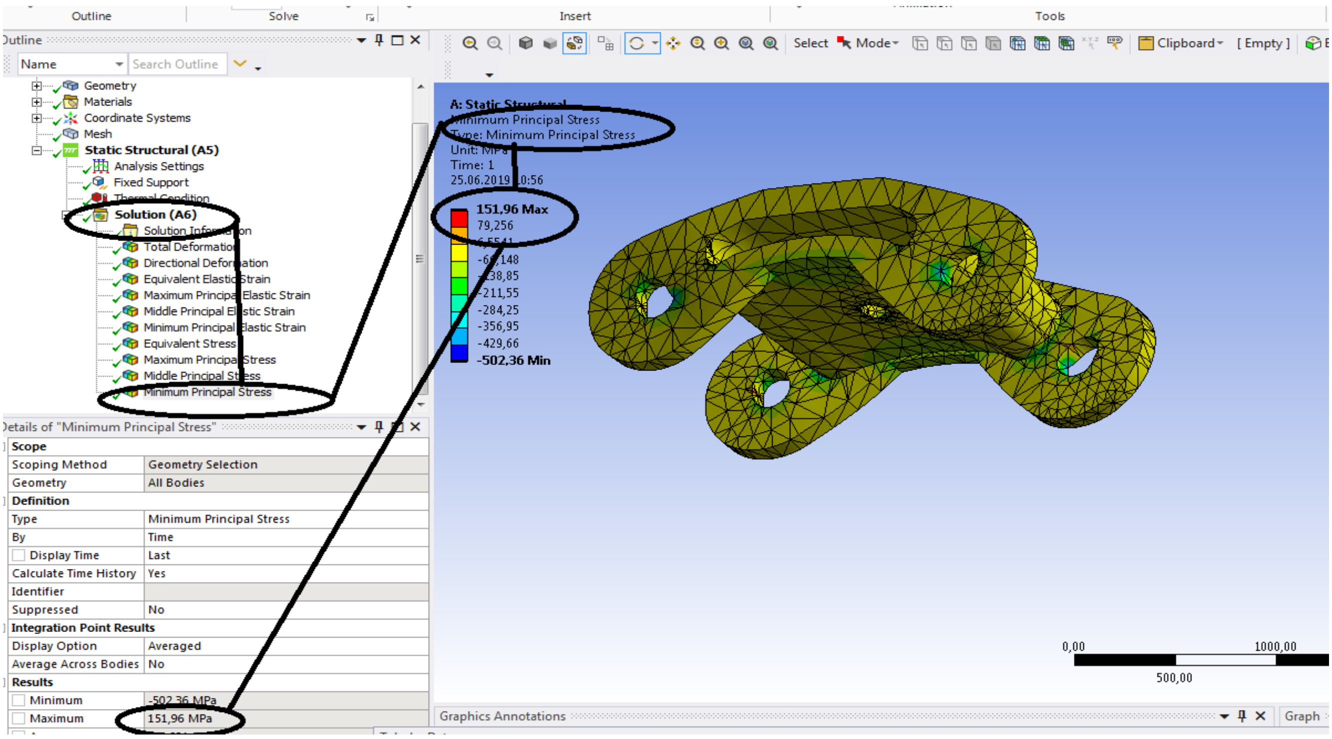


Figura 67 -Tensiunile principale $\sigma 3$ [MPa]

1.5 Static structural termic si mecanic (forta F = -600000N si temperatura de incercare 60 de grade Celsius)

- **Se deschide progrmaul Ansys Workbench;**
- **Se cauta geometria in IGS (boghiul de studiat)- insert-browse-Boghiu-IGS ;**
- **Clic pe boghiu IGS , se selecteaza ca geometrie boghiul;**

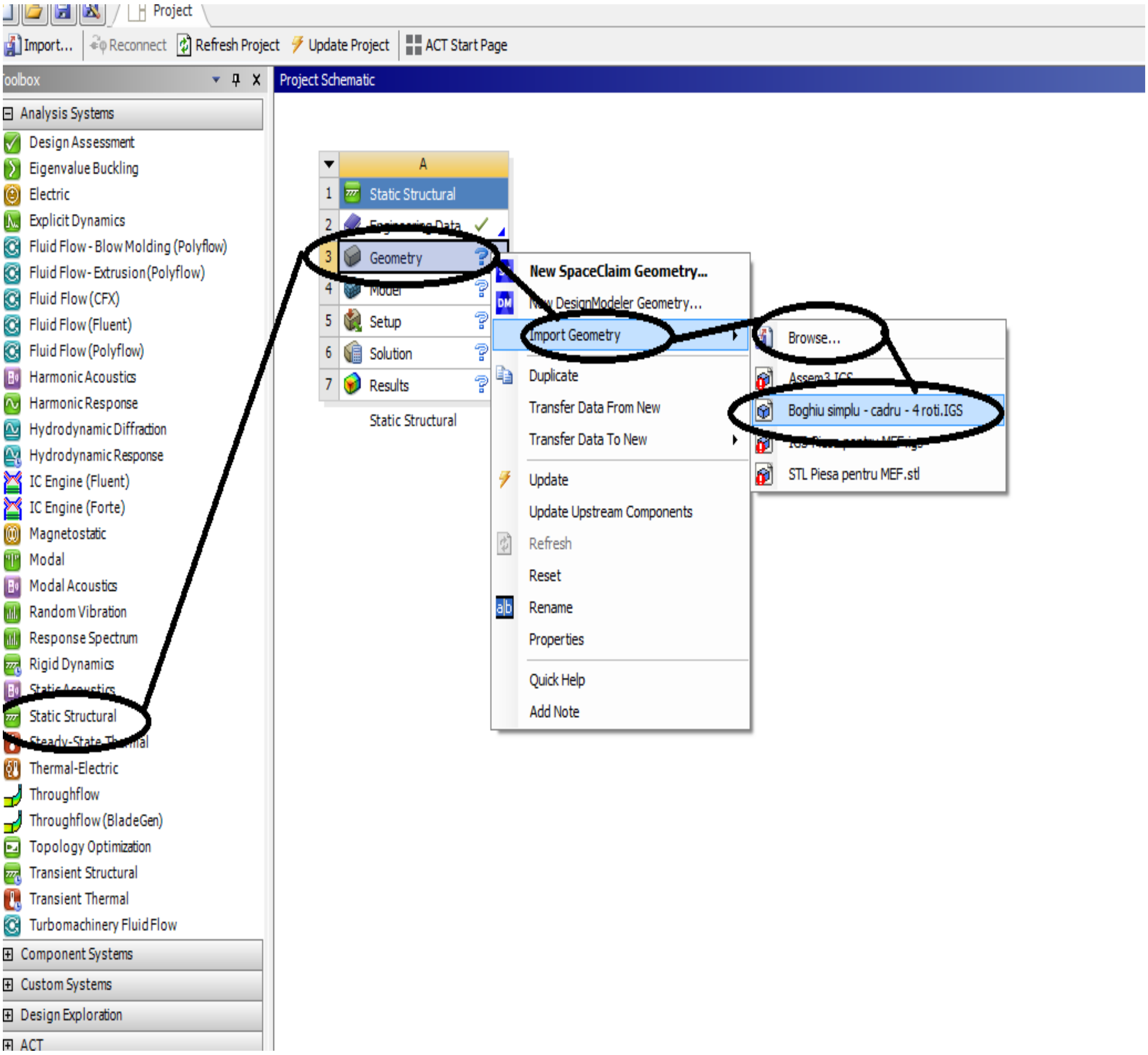


Figura 68 – Deschderea programului Ansys- Aplicarea geometriei

Dublu clic pe model si se deschide si se deschide Static structural – Mechanical Ansys

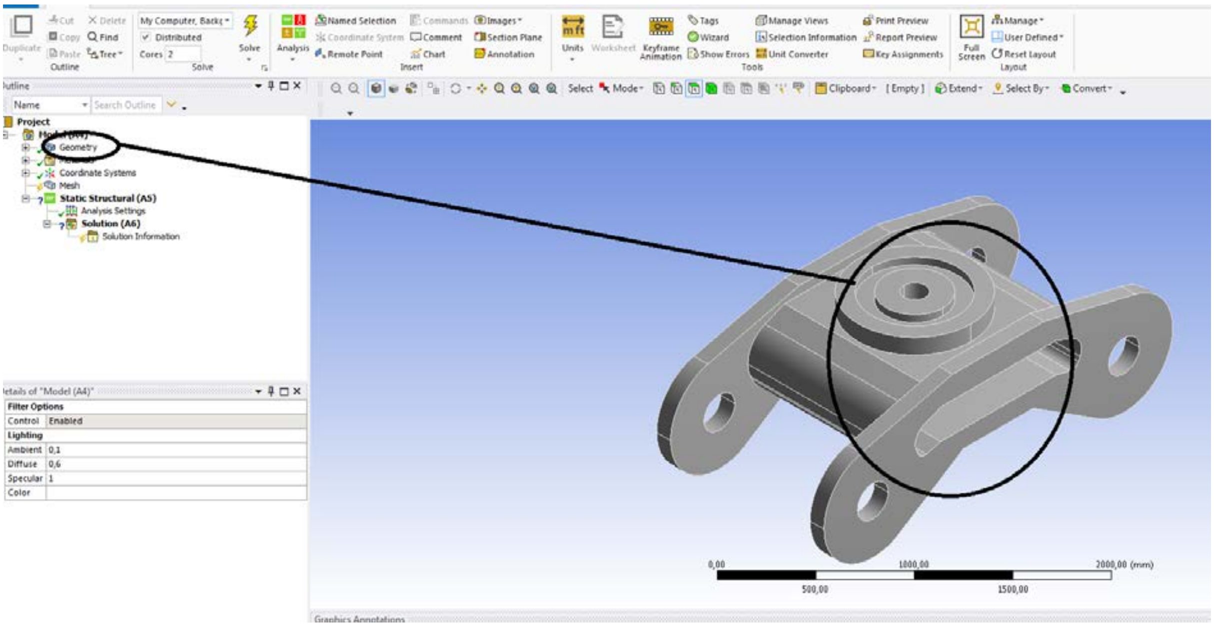


Figura 69 – Geometria vizualizata

- Se discretizeaza piesa , se da pe mech apoi clic pe mesh si generate mesh clic se obtine o discretizare grosolana;

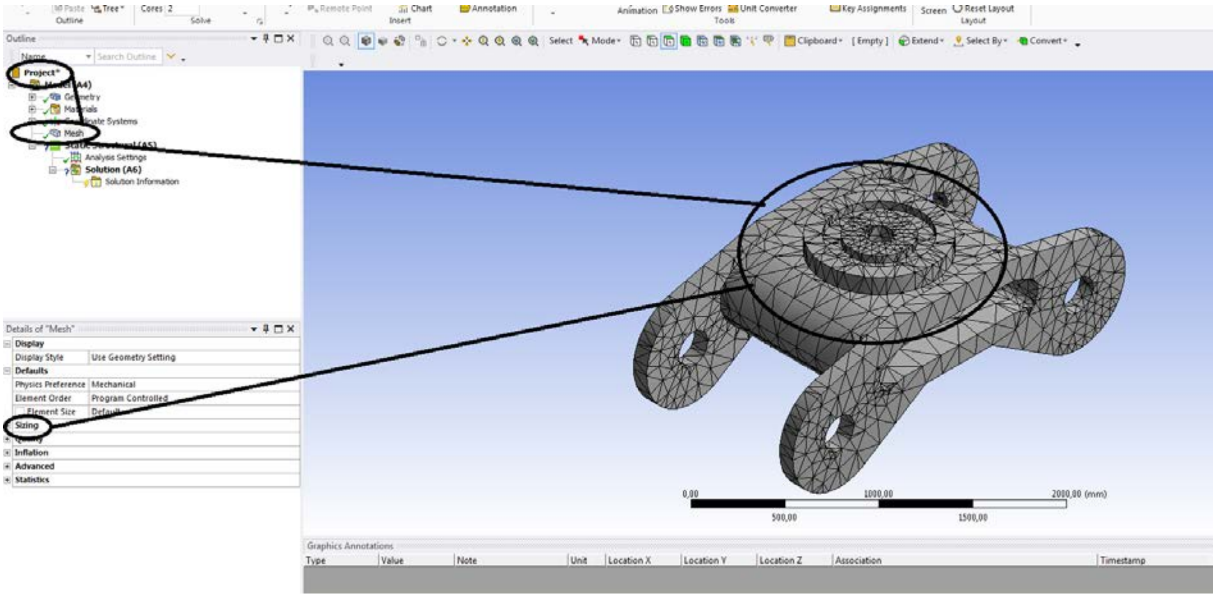


Figura 70 –Project-Model (A4)-Discretizare grosolana

-Se duce la detalii discretizare din casuta stanga jos;

- la marime (sizing) care este grosolana (coarse) ;

- se alege o discretizare fina (Fine);

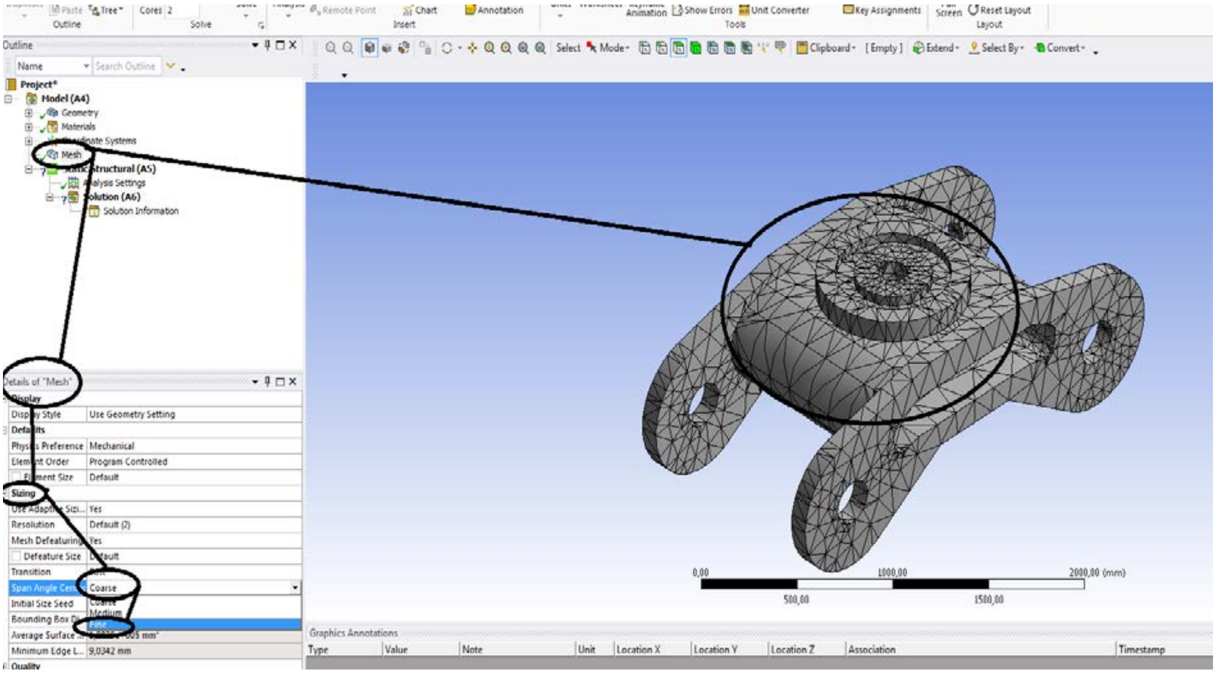


Figura 71 –Project-Model (A4)-Discretizare grosolana- Details of Mesch

-se da clic pe fine apoi se merge la mesch sus si se da update;

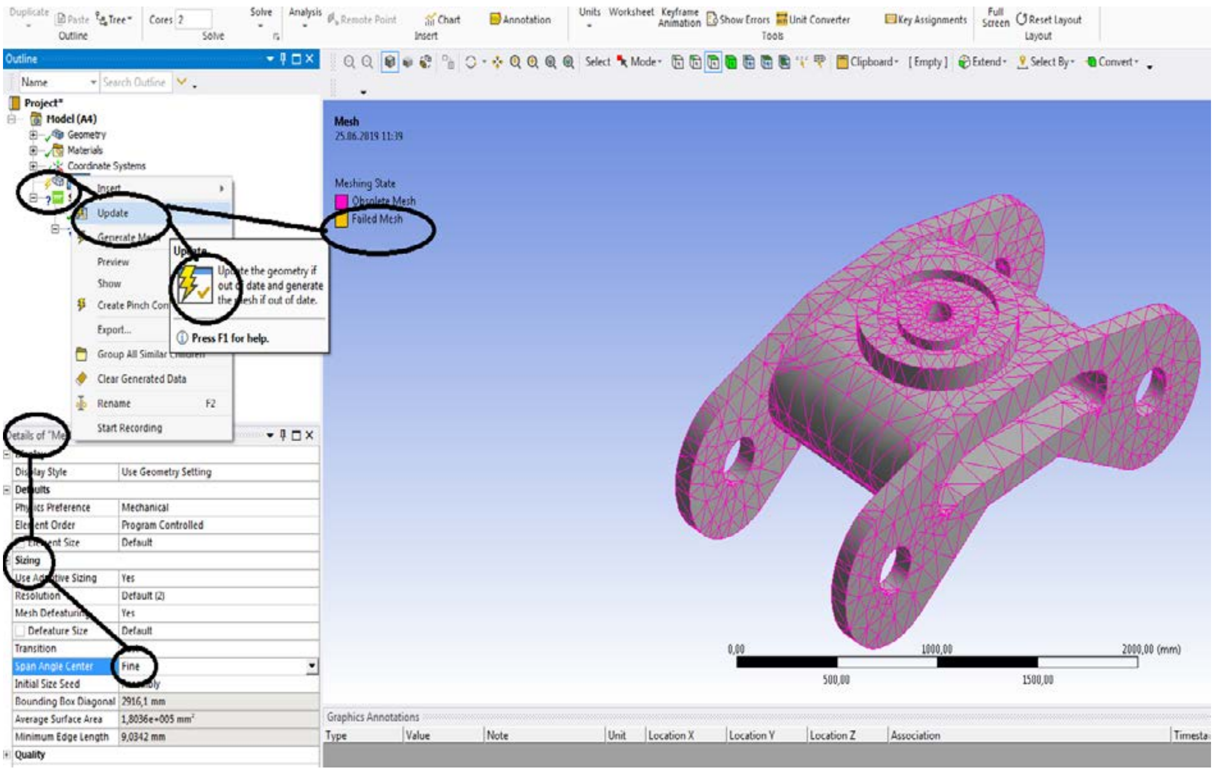


Figura 72 –Project-Model (A4)-Discretizare grosolana- Details of Mesch-Spre discretizare fina

Dupa ce se face actualizarea (Update) se obtine discretizarea fina;

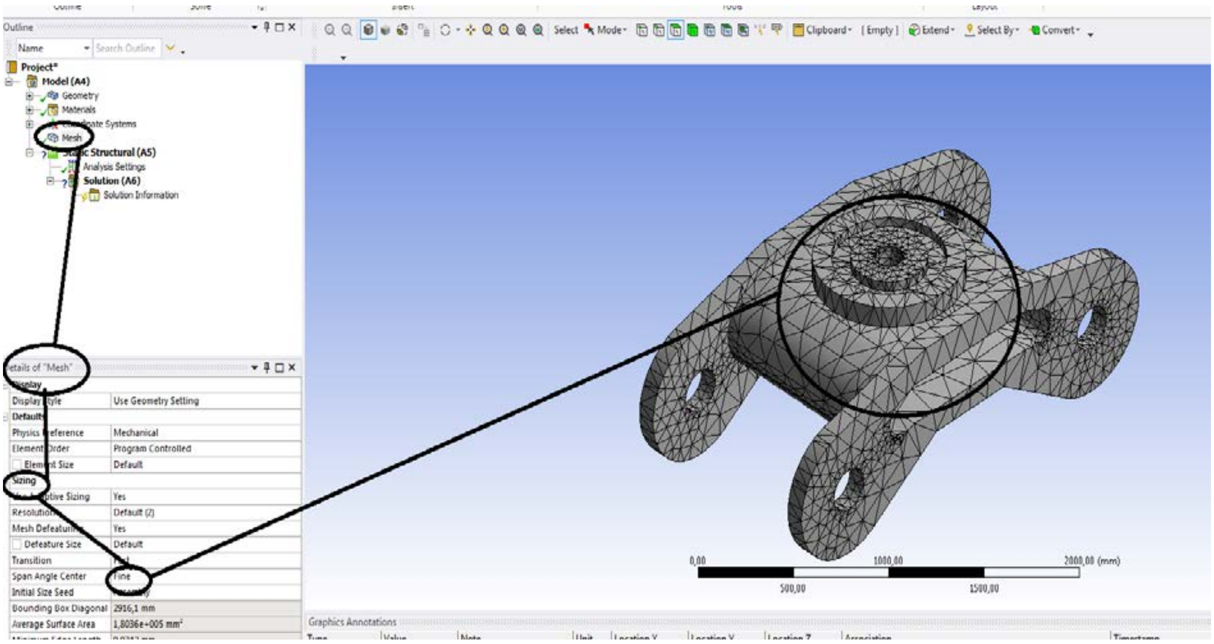


Figura 73 –Project-Model (A4)-Discretizare grosolana- Details of Mesch-Discretizare fina

-se incastreaza boghiul pe suprafetele selectate cu verde de pe boghiu

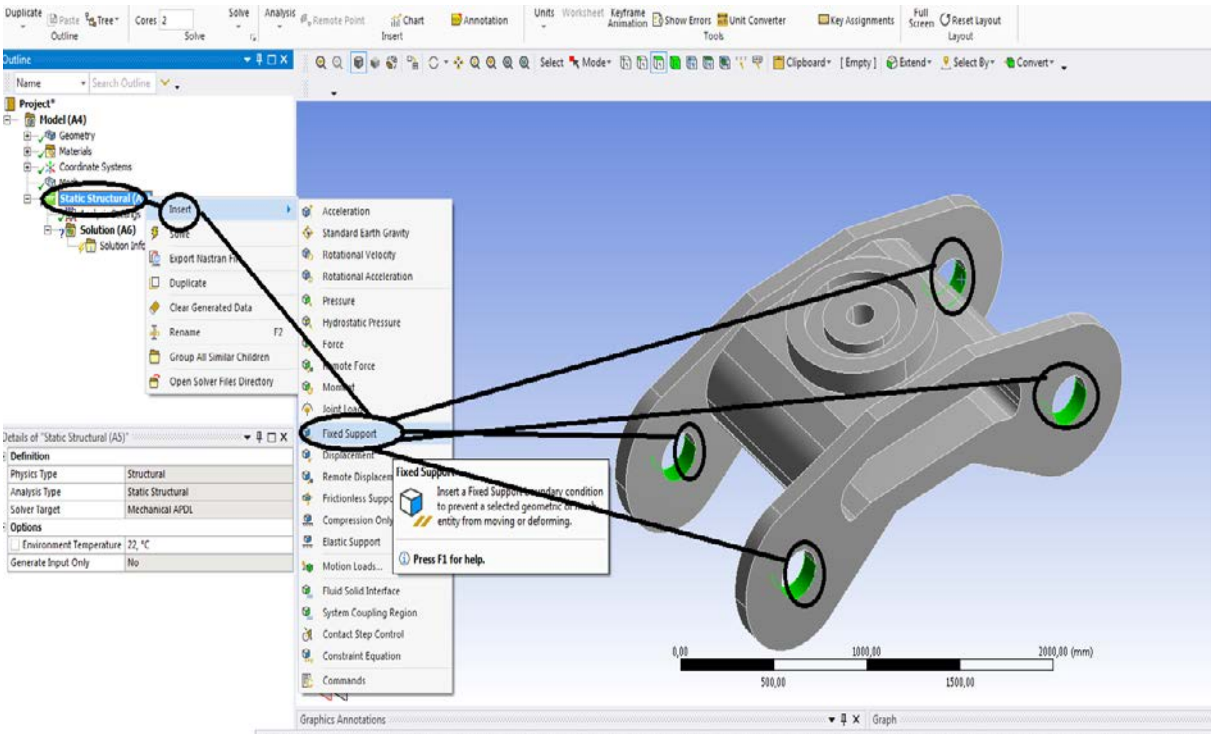


Figura 74 – Selectarea suprafetelor de reazem

-se da clic pe incastrare (fixed support) ;

- apar suprafetele incastrate cu albastru pe boghiu si verde la fix supported in Project (din stanga);

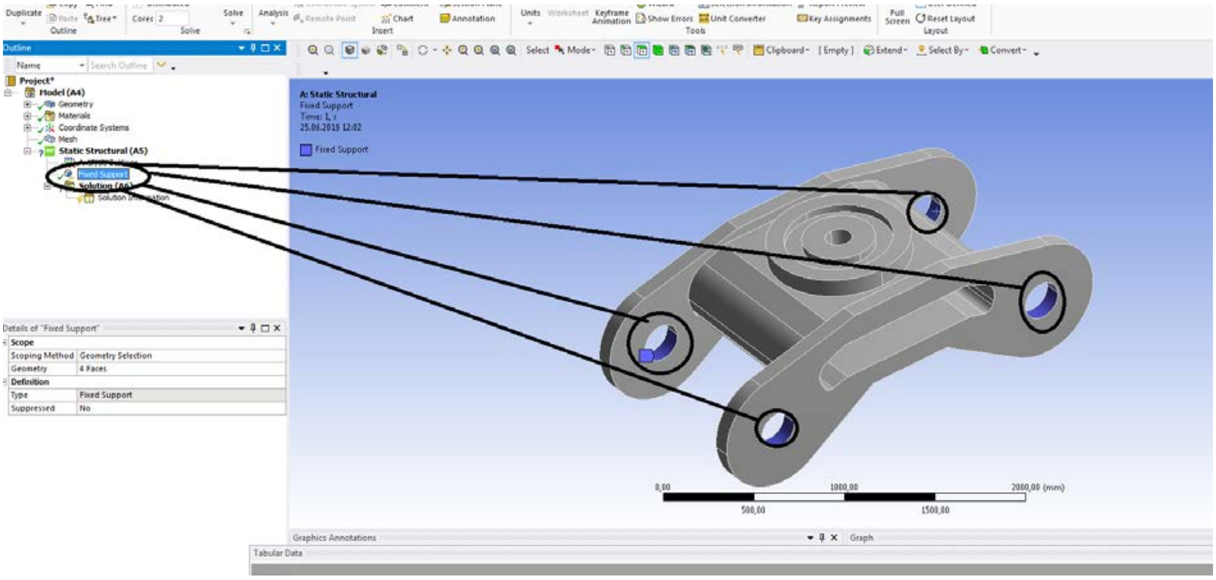


Figura 75 –Suprafete de reazem

- **Se selecteaza suprafata de incarcare;**
- **Se merge la static structural din proiect (Project)-insert- Forta (force) - se da clic pe force ;**

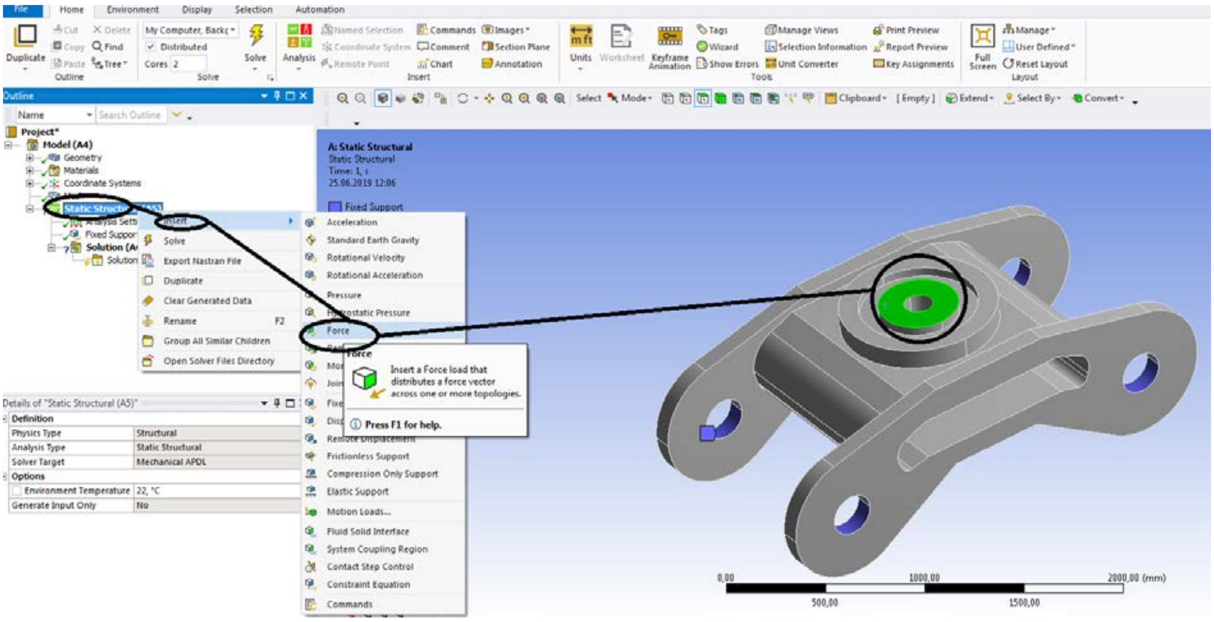


Figura 76 –Selectarea suprafetei de incarcare

-dupa clic pe force apar urmatoarele;

- se merge le detalii forta –casuta din stanga jos-force – vector- componente dupa axele :OX;OY;OZ;

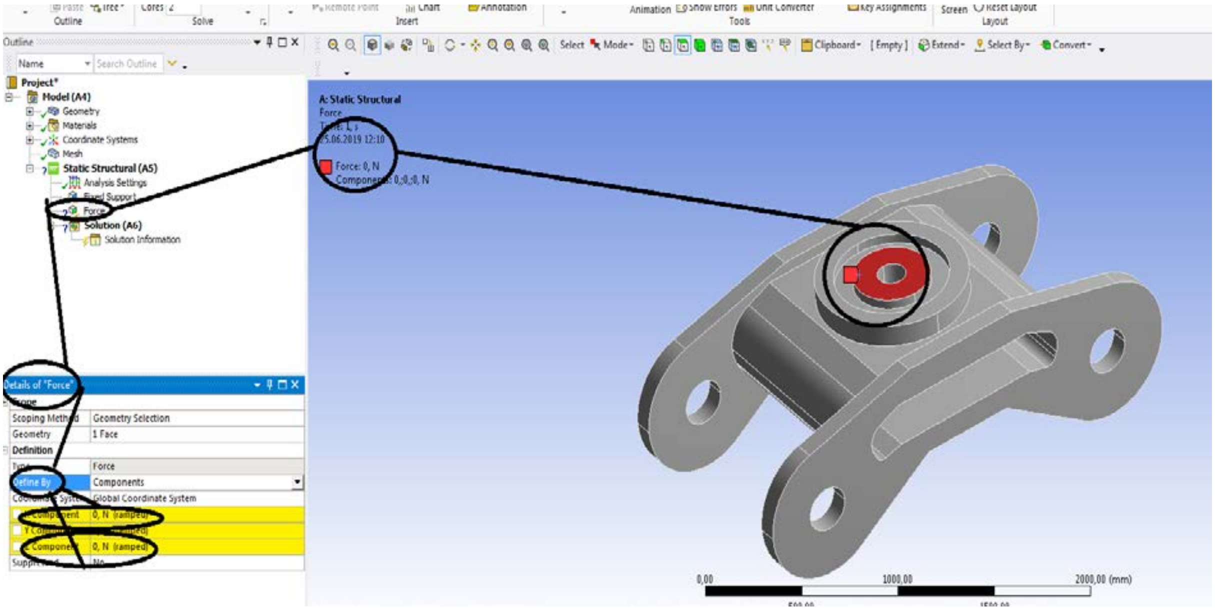


Figura 77 –Suprafata pregatita de incarcare

-s-a aplicat o forta F = -600000 N dupa axa OY;

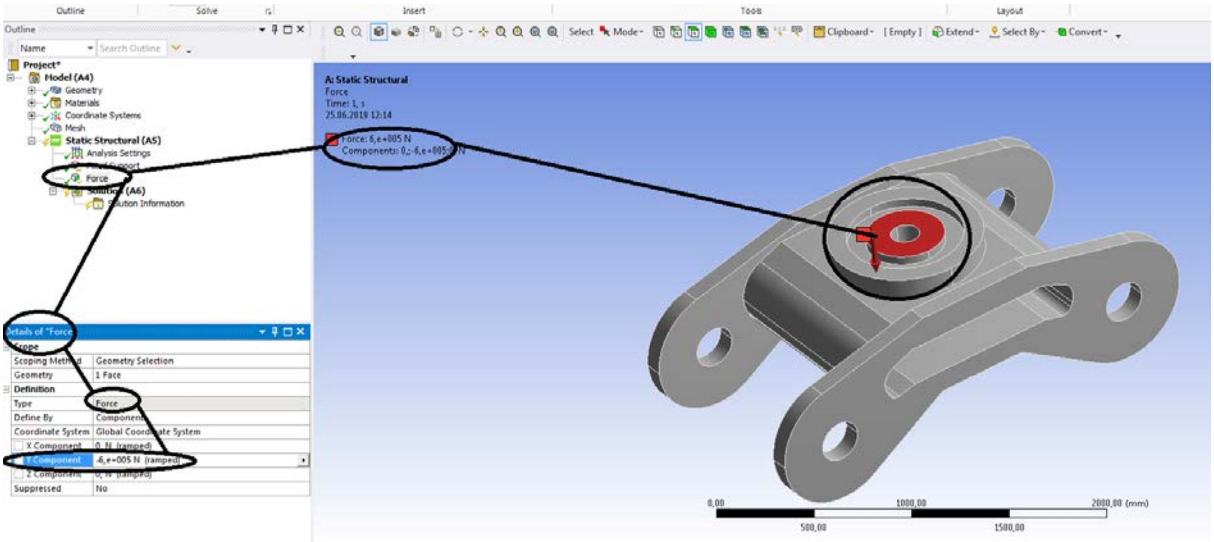


Figura 78–Suprafata incarcata cu forta F

-se alege temperatura de incercare;

- se selecteaza tot boghiul (nu suprafetele lui);

-in casuta din stanga jos se selecteaza temperatura de incercare ;

- aici se aplica foeta de incercare si temperatura de incercare in acelasi timp, se aplica principiul surapunerii efectelor;

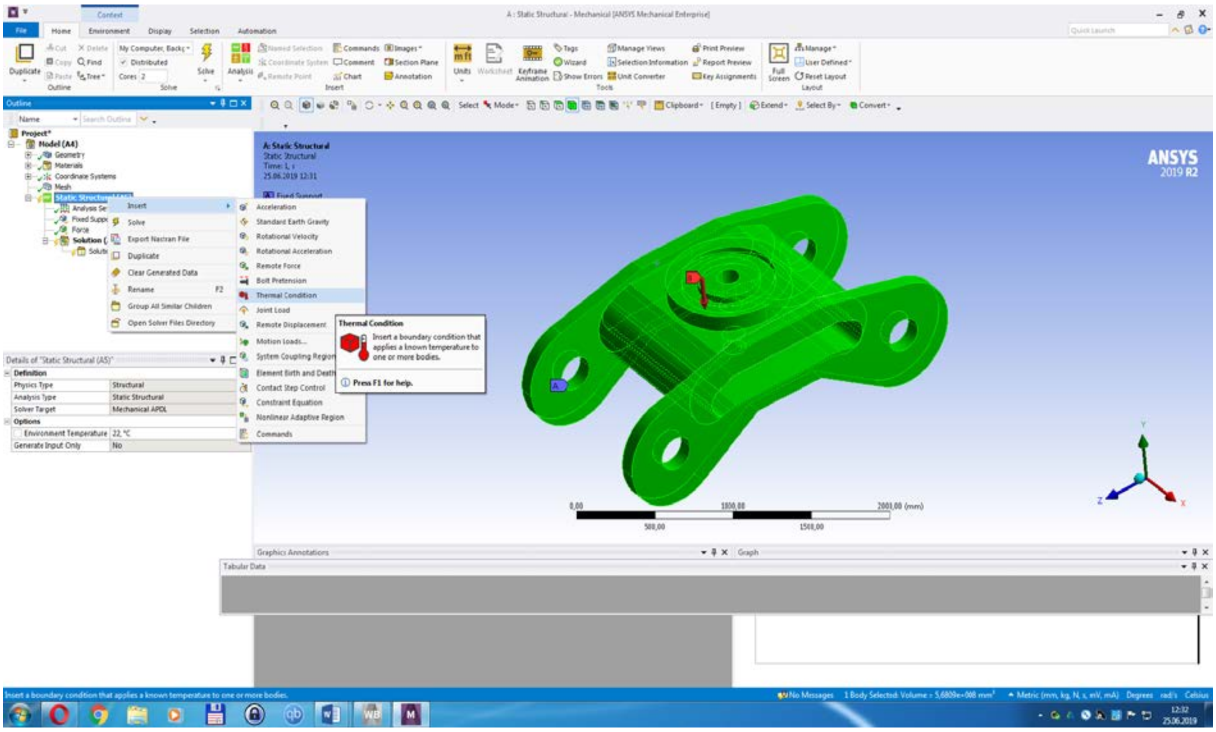


Figura 79 – Selectarea intregului volum al piesei pentru incarcarea cu o temperatura

In static structural exista incastrare , forta aplicata si temperatura de incercare;

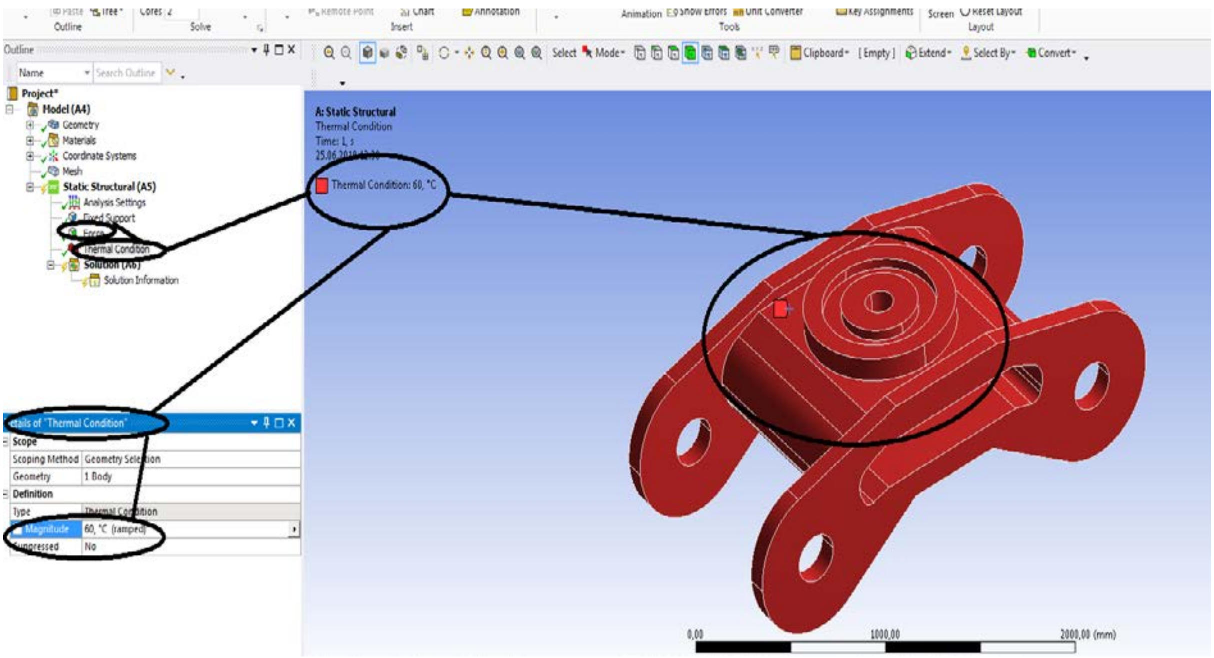


Figura 80 – Temperatura de incercare

-la rezolvare (Solution A6) s-au pus toate solutiile care intereseaza;

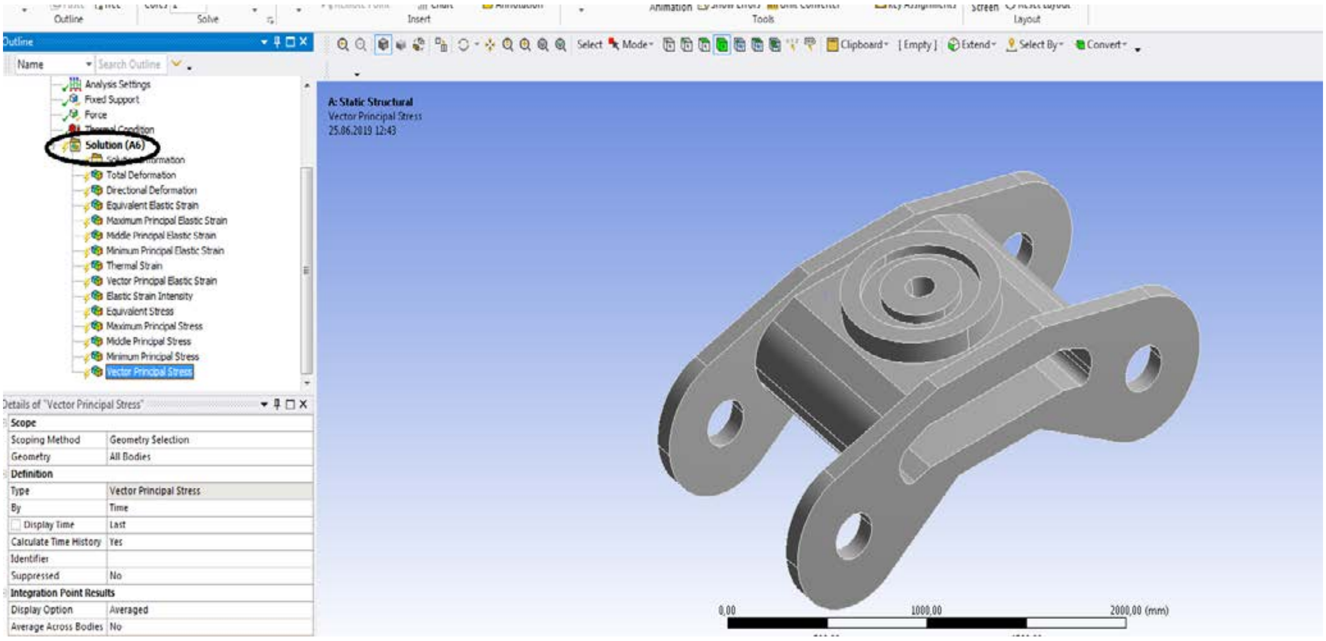


Figura 81 –Pregatirea de rezolvare

- **Se da sa se rezolve (solve);**

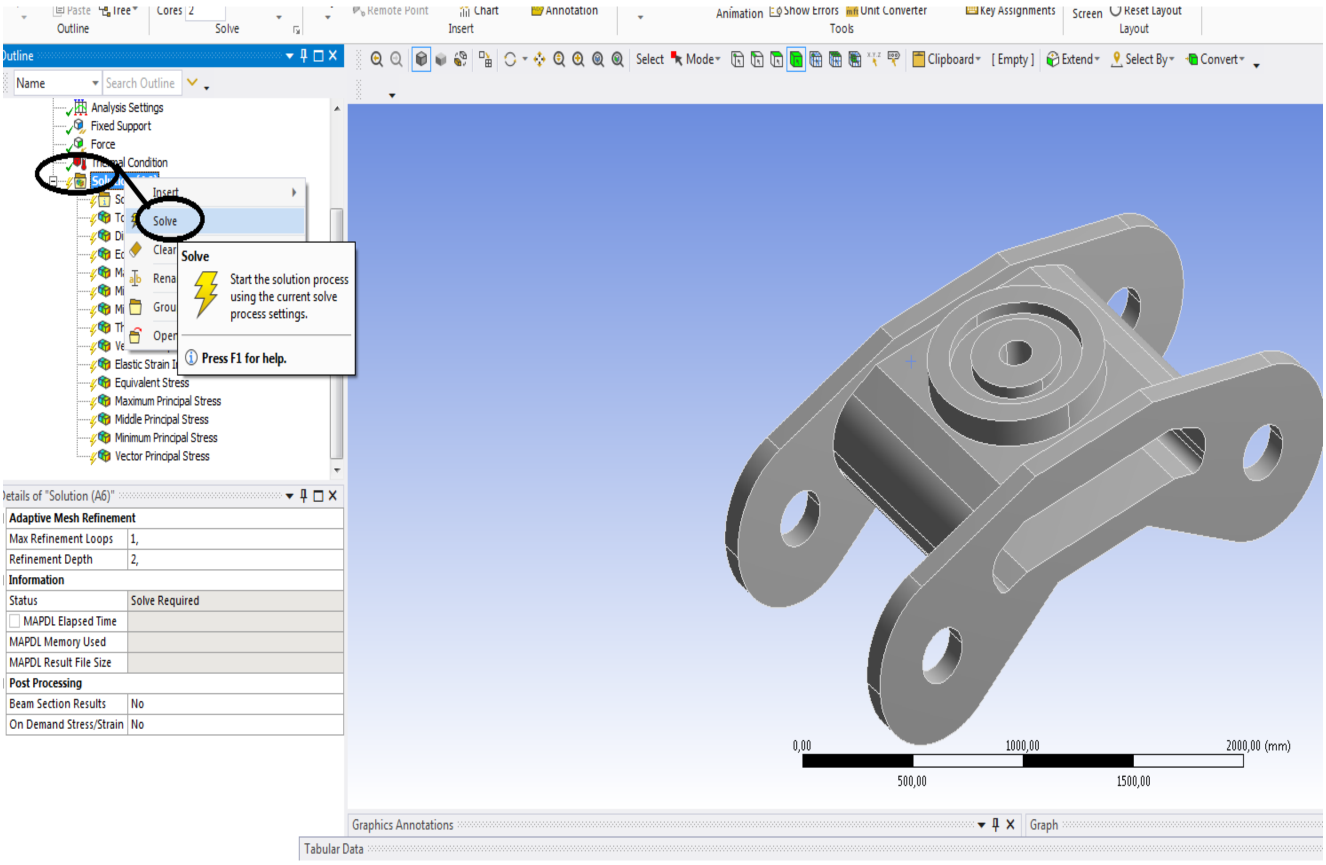


Figura 82 –Solution – Solve

-Aproape de solutia finala;

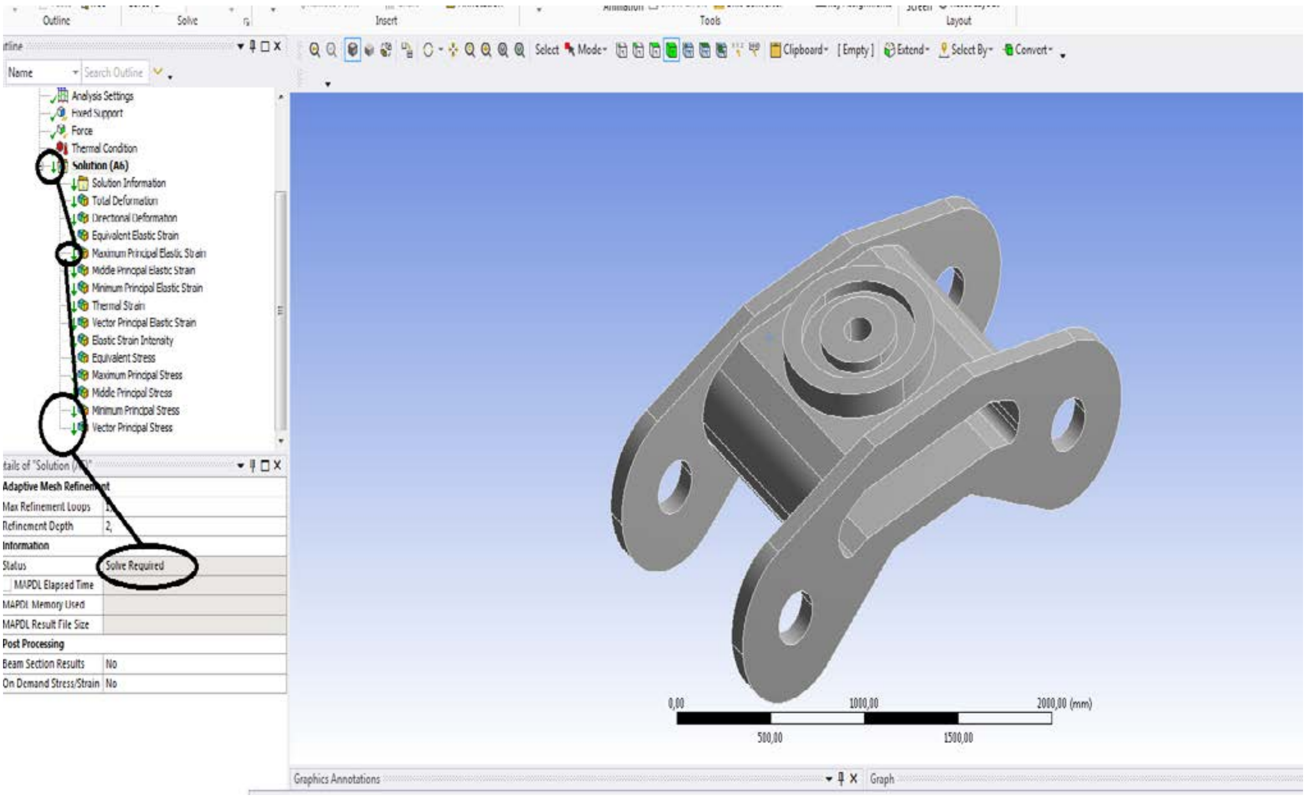


Figura 83 –Solution – Solve- Solve Required

- **Se da aflati rezultatele (Get Results);**

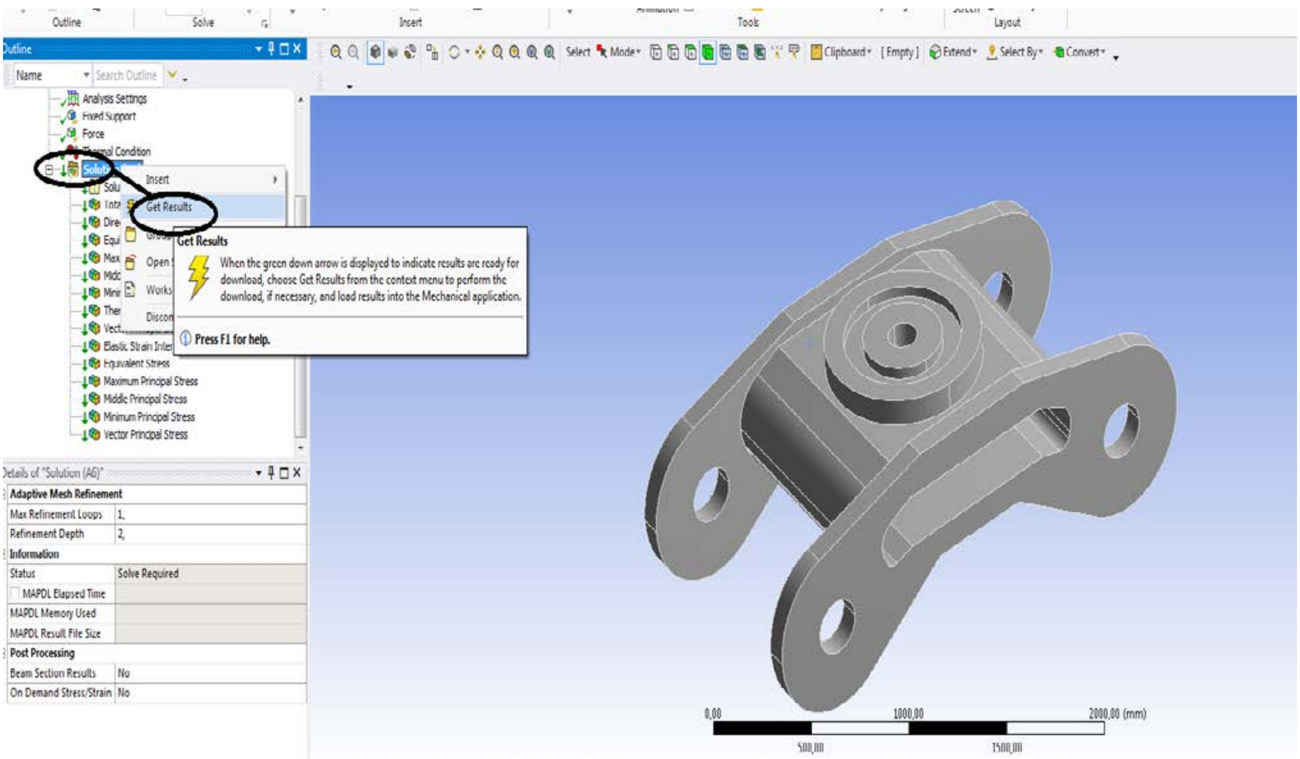


Figura 84 –Solution – Solve- Solve Required- Get Results

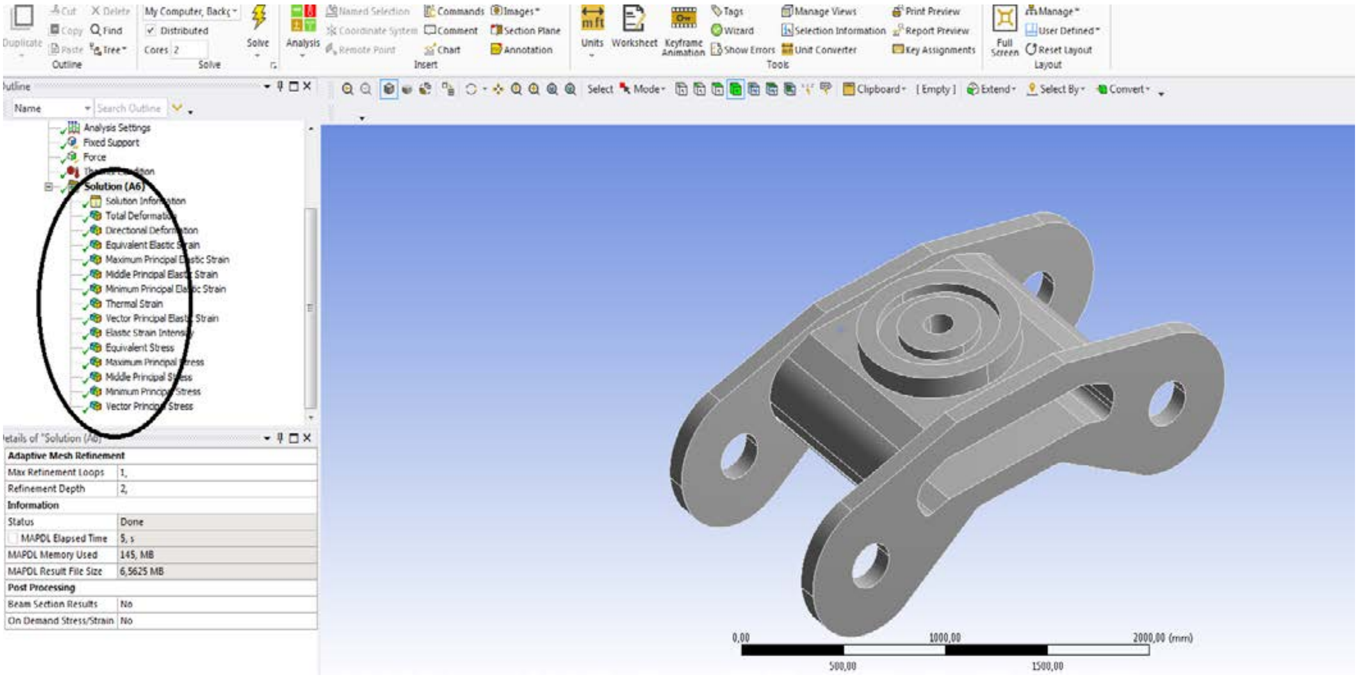


Figura 85–Solution – Solve- Solve Required- Get Results- Rezultate finale

1.6 Static structural mecanic si termic boghiu -Rezultate

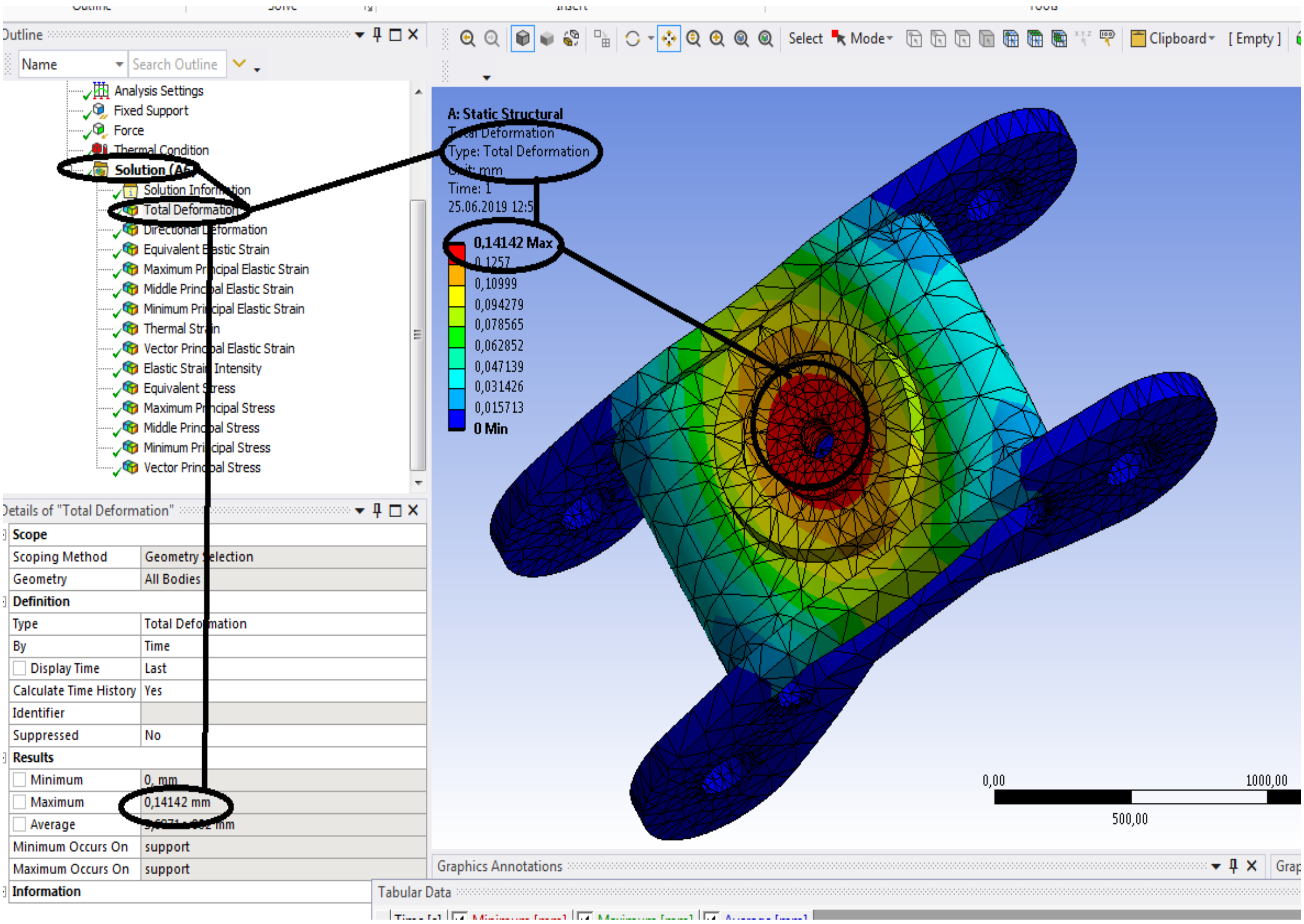


Figura 86 - Deformații totale [mm]

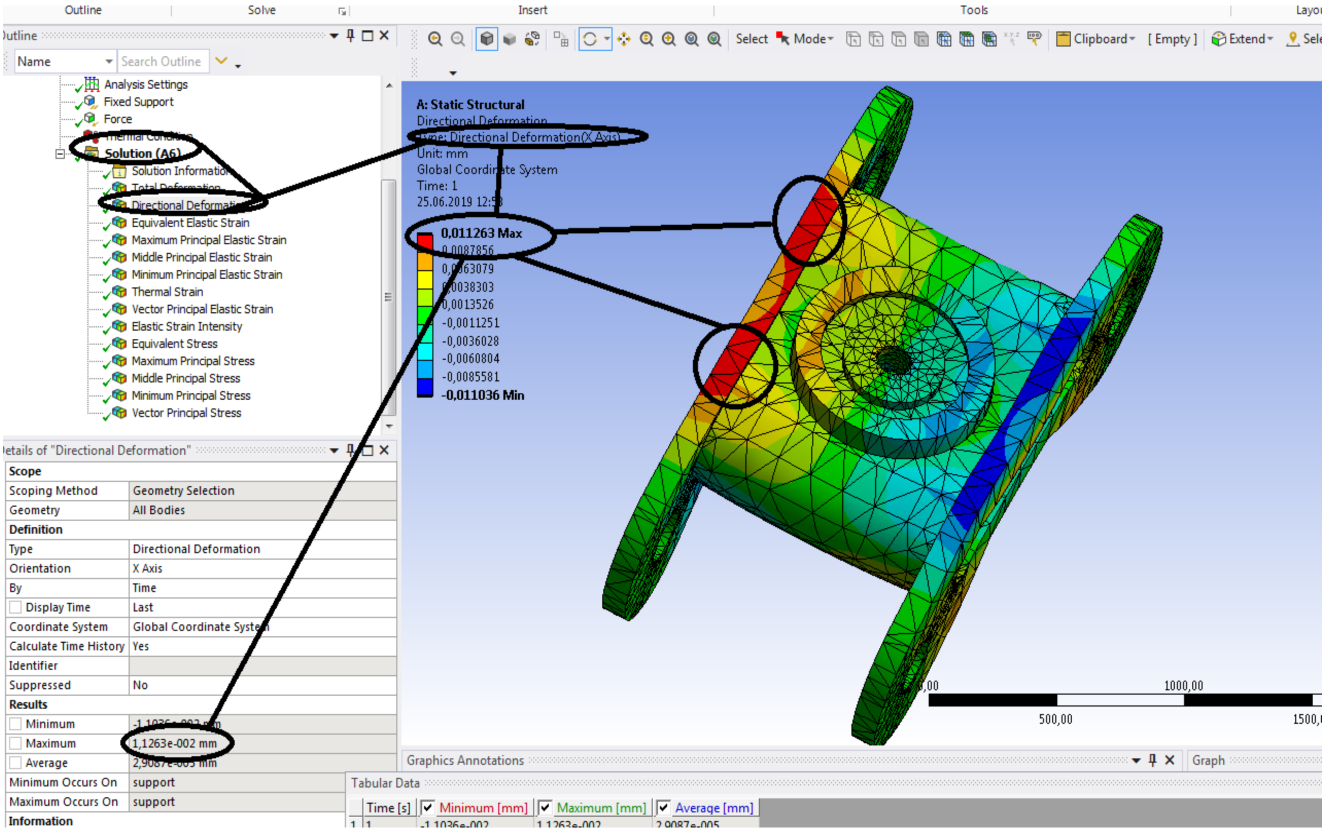


Figura 87 -Deformații direcționale pe axa x [mm]

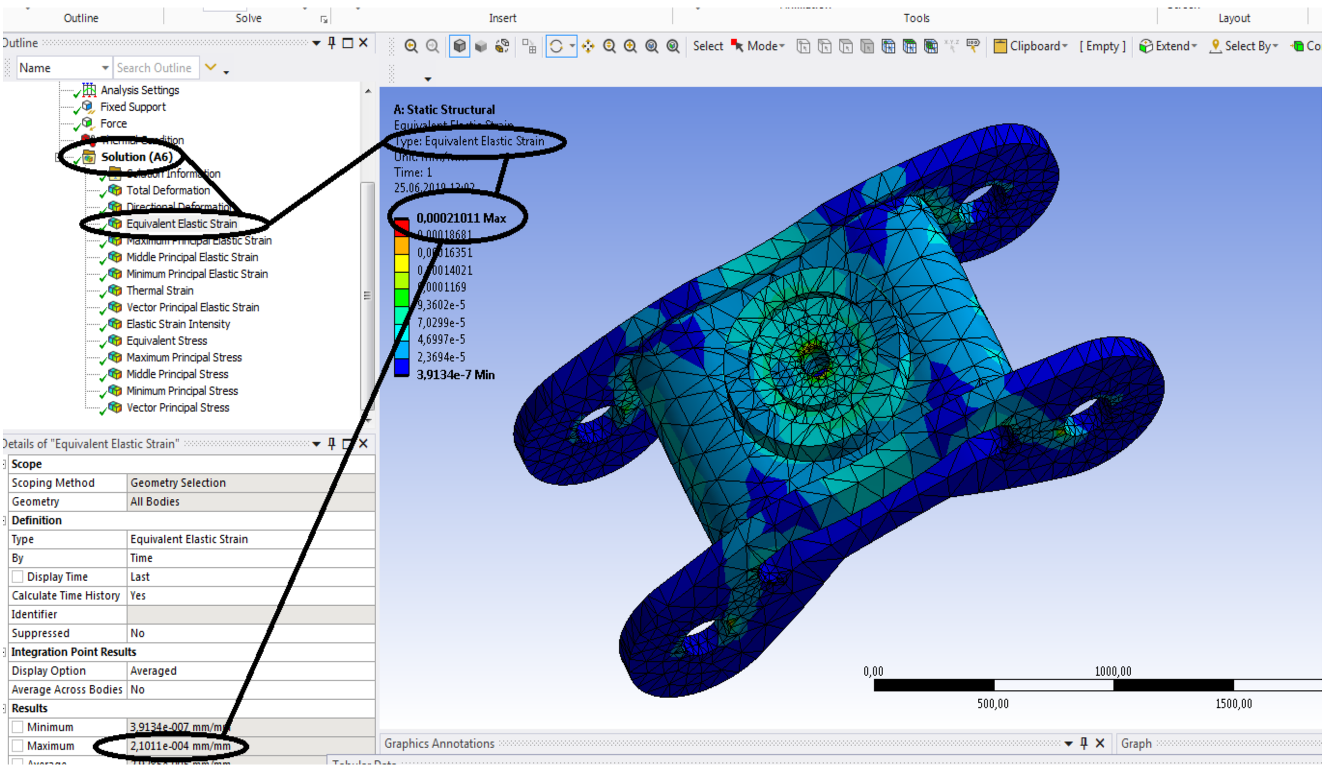


Figura 88 - Deformațiile specifice echivalente ε [mm/mm]

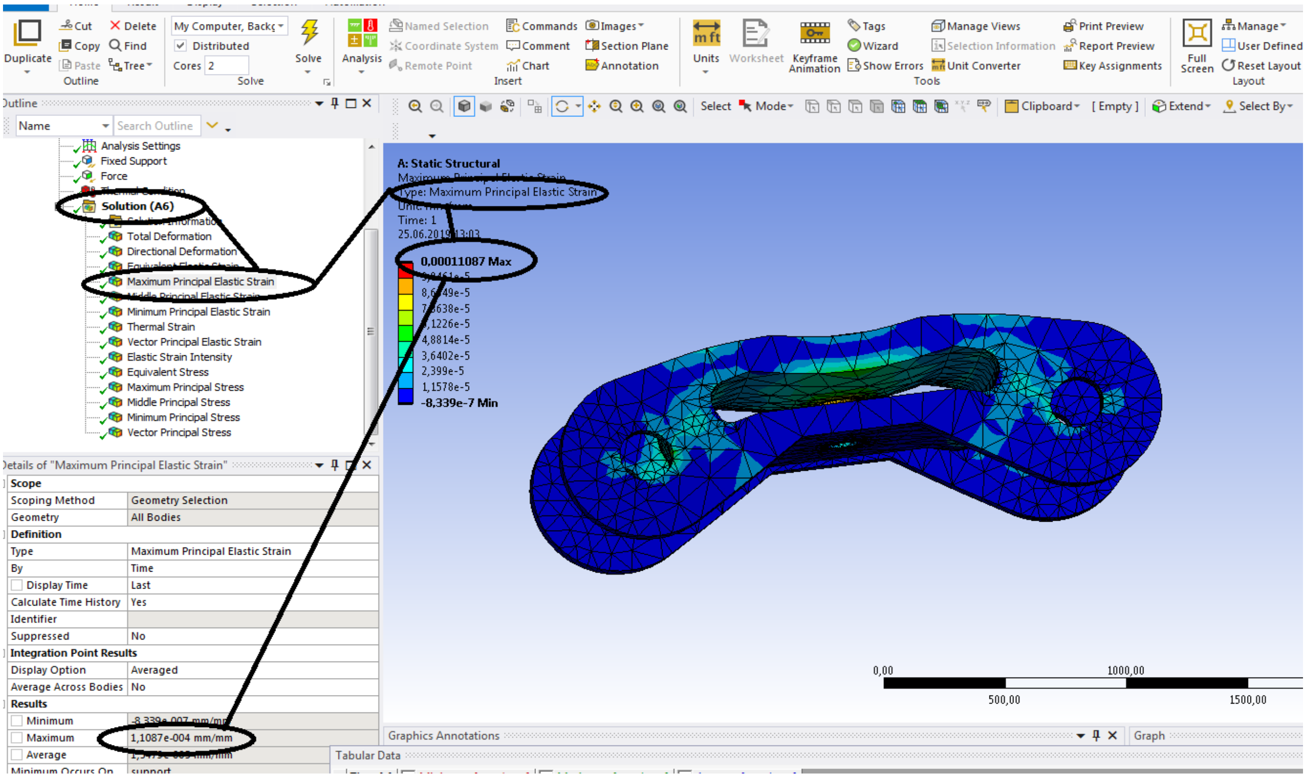


Figura 89 - Deformațiile specifice principale - ε1 [mm/mm]

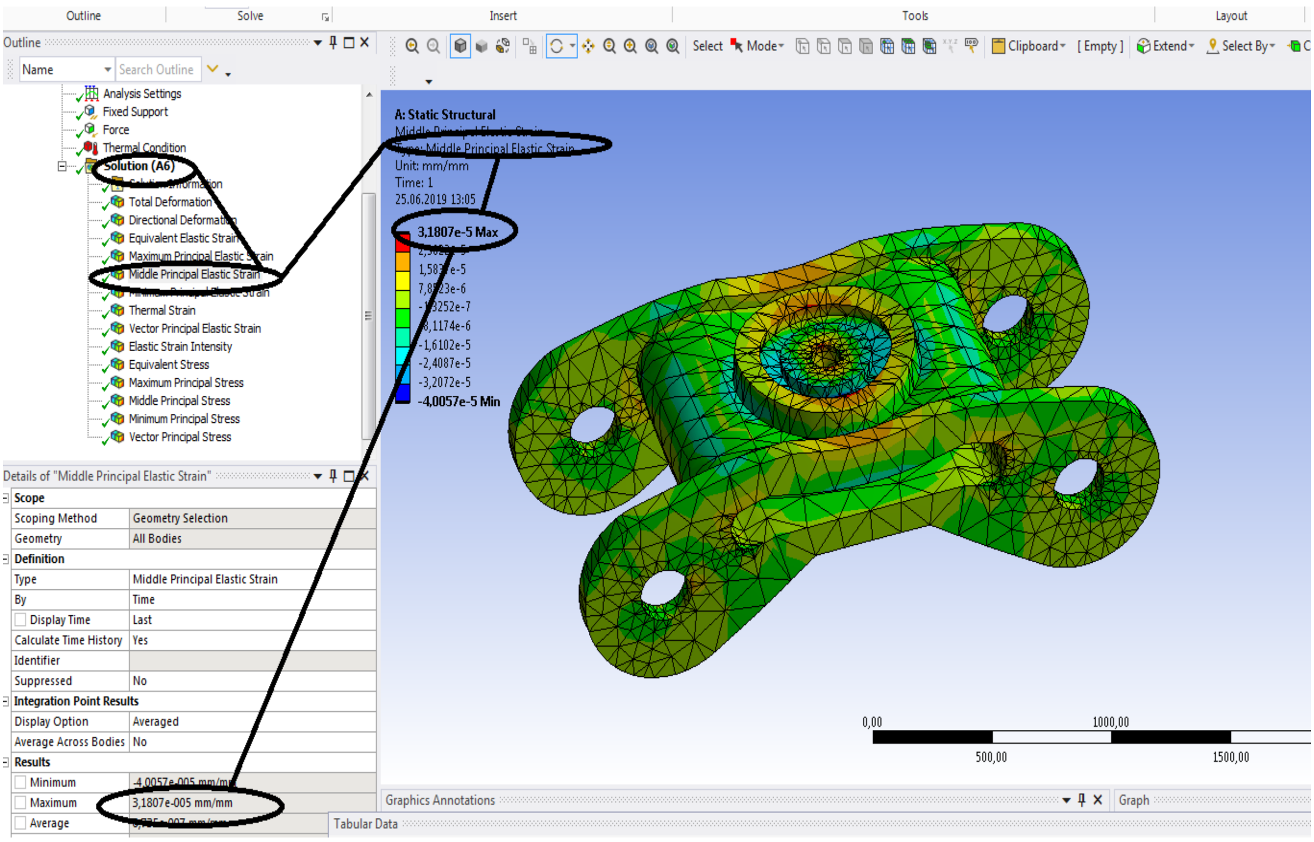


Figura 90- Deformațiile specifice principale ε2 [mm/mm]

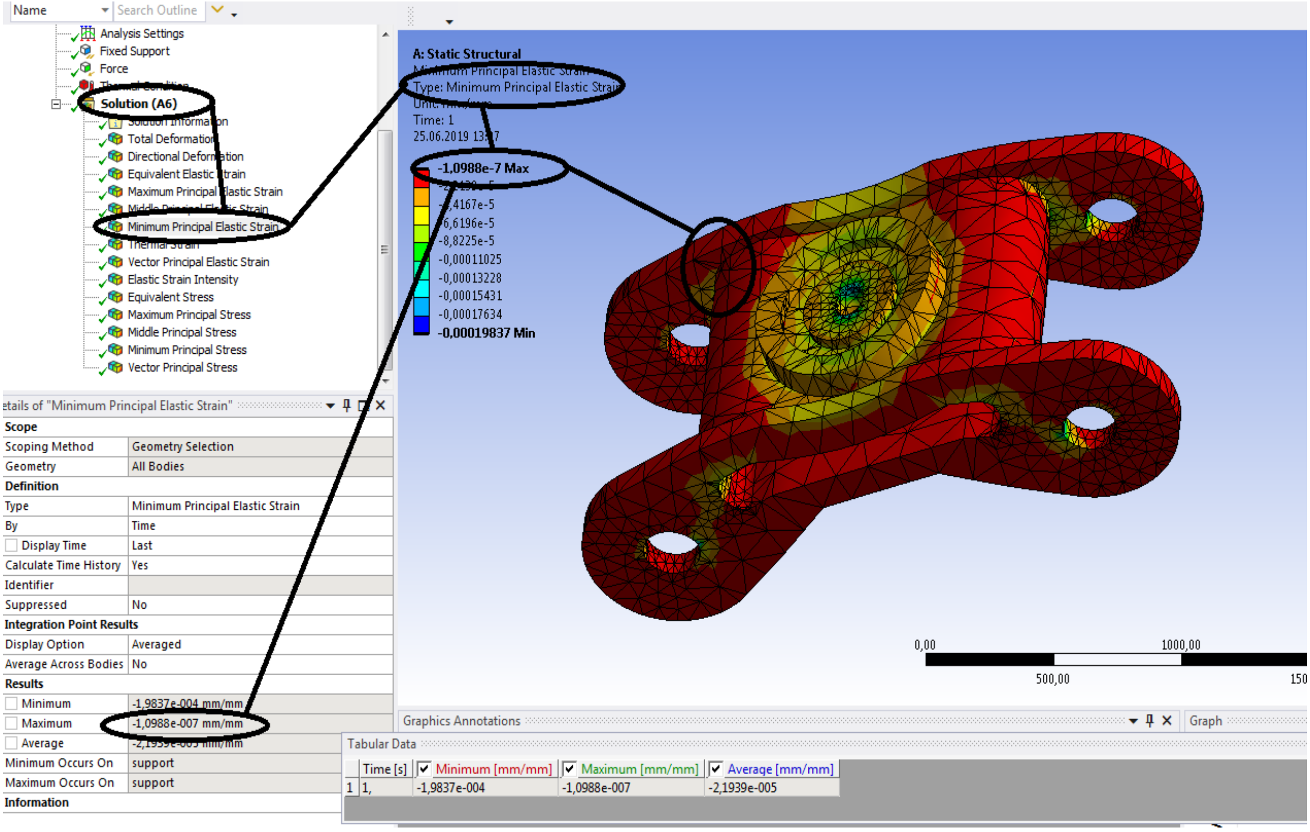


Figura 91 - Deformațiile specifice principale ε3 [mm/mm]

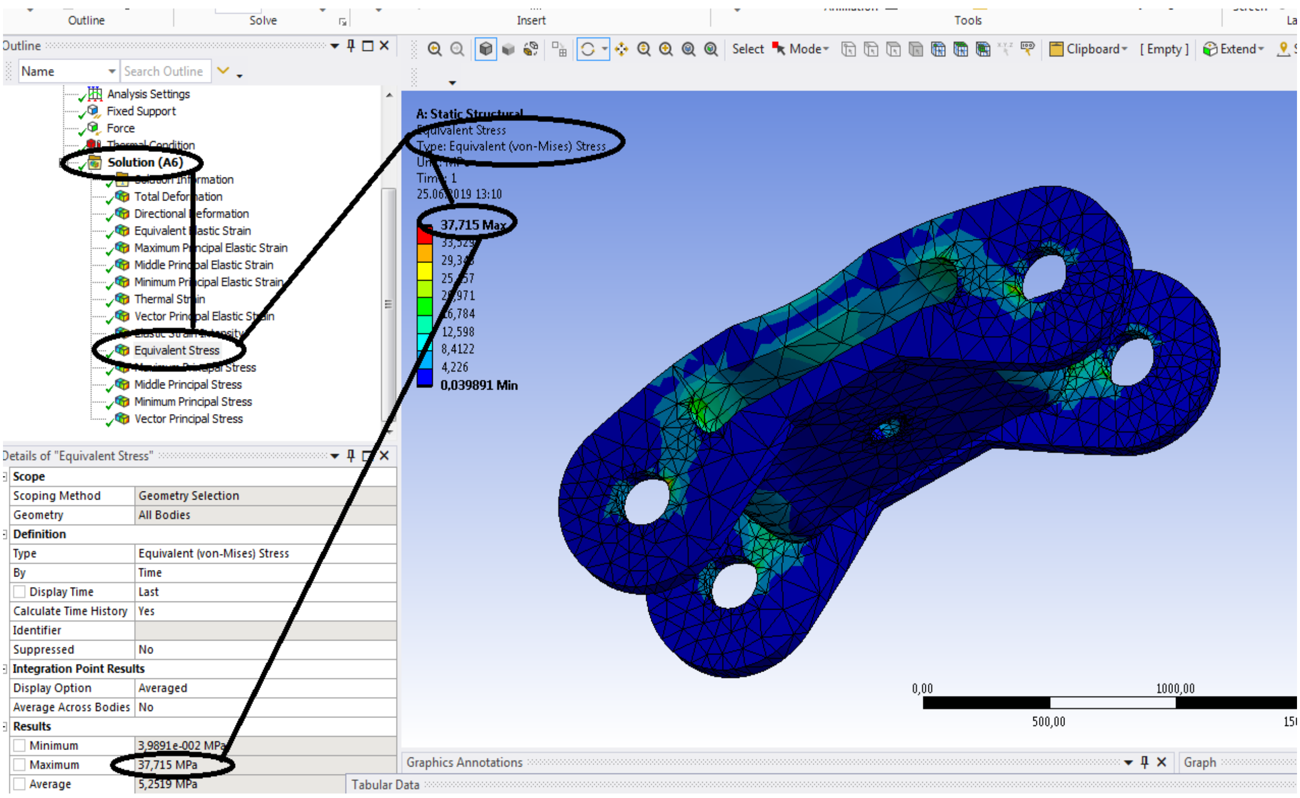


Figura 92 - Tensiunile echivalente von Mises [MPa]

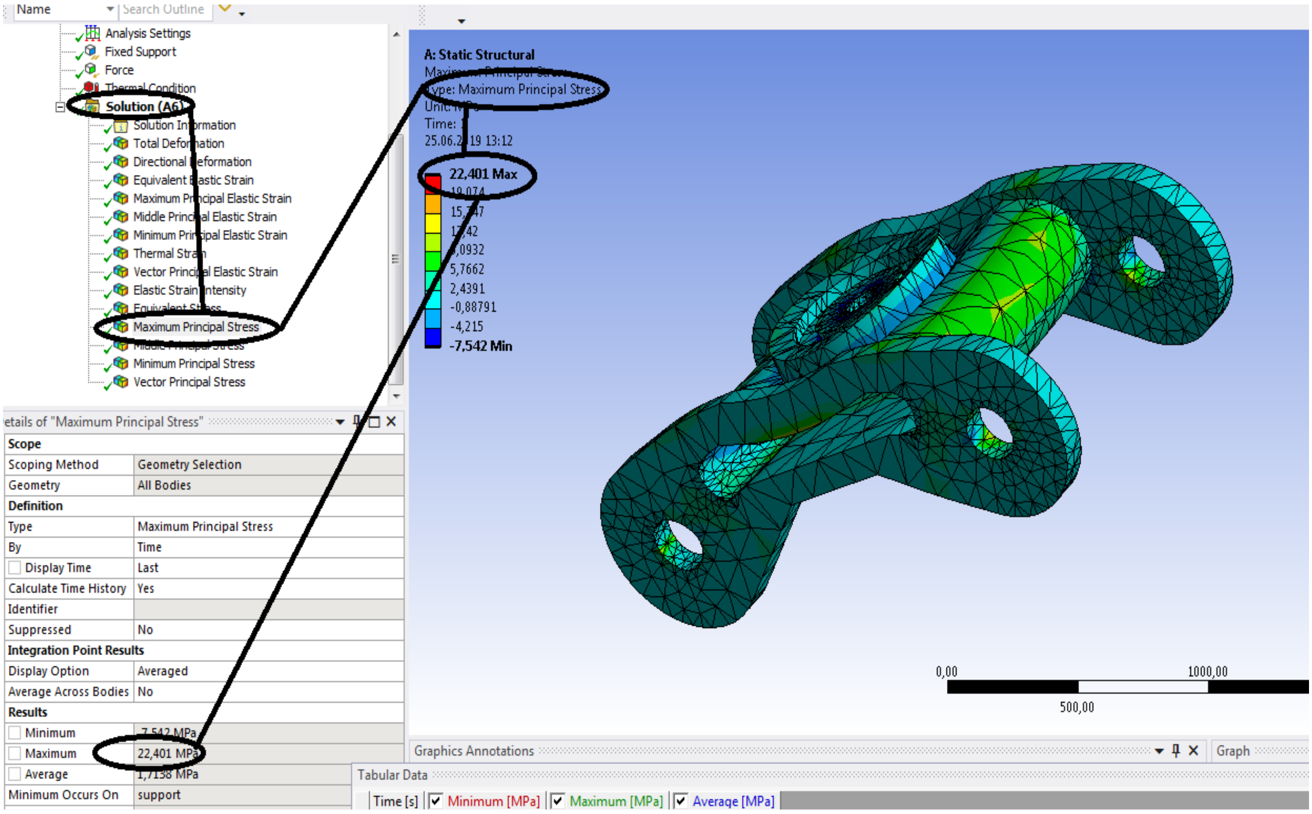


Figura 93 - Tensiunile principale $\sigma 1$ [MPa]

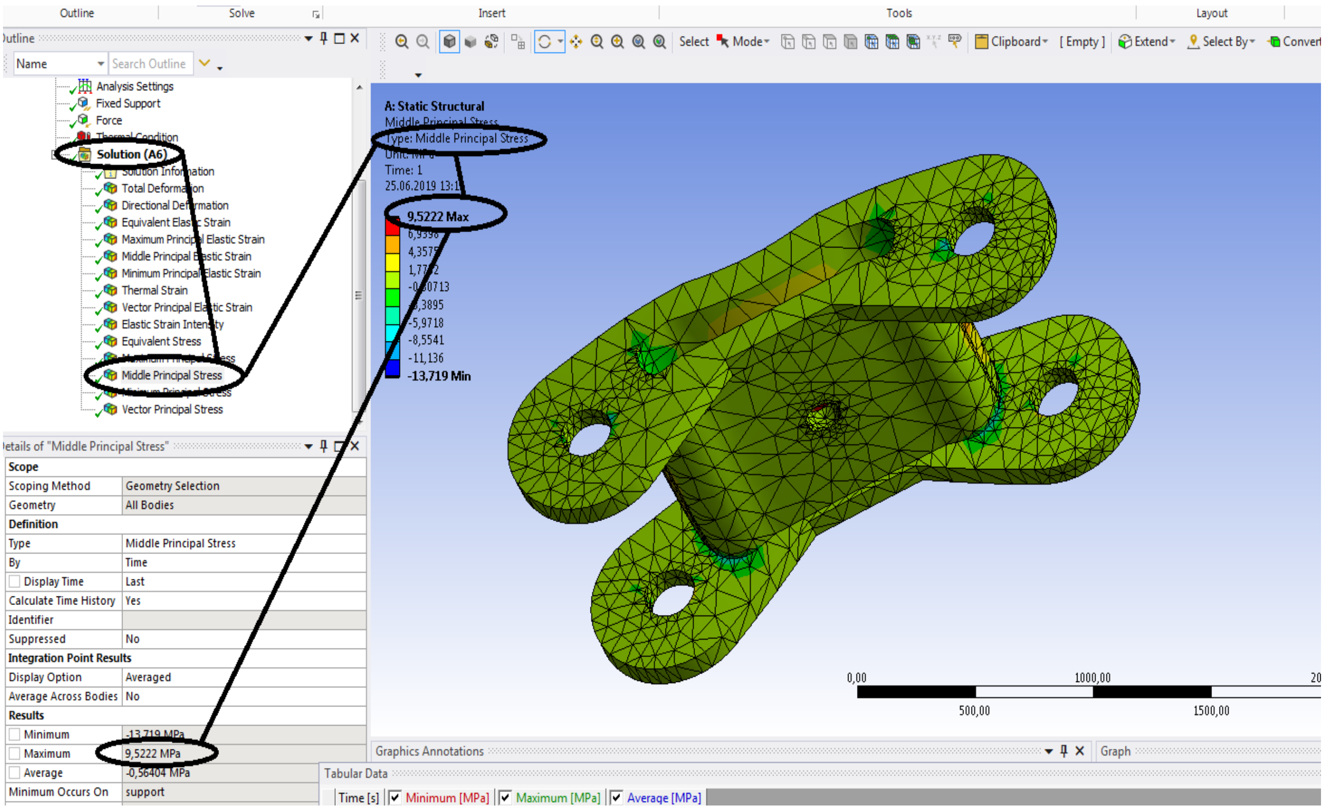


Figura 94 - Tensiunile principale $\sigma 2$ [MPa]

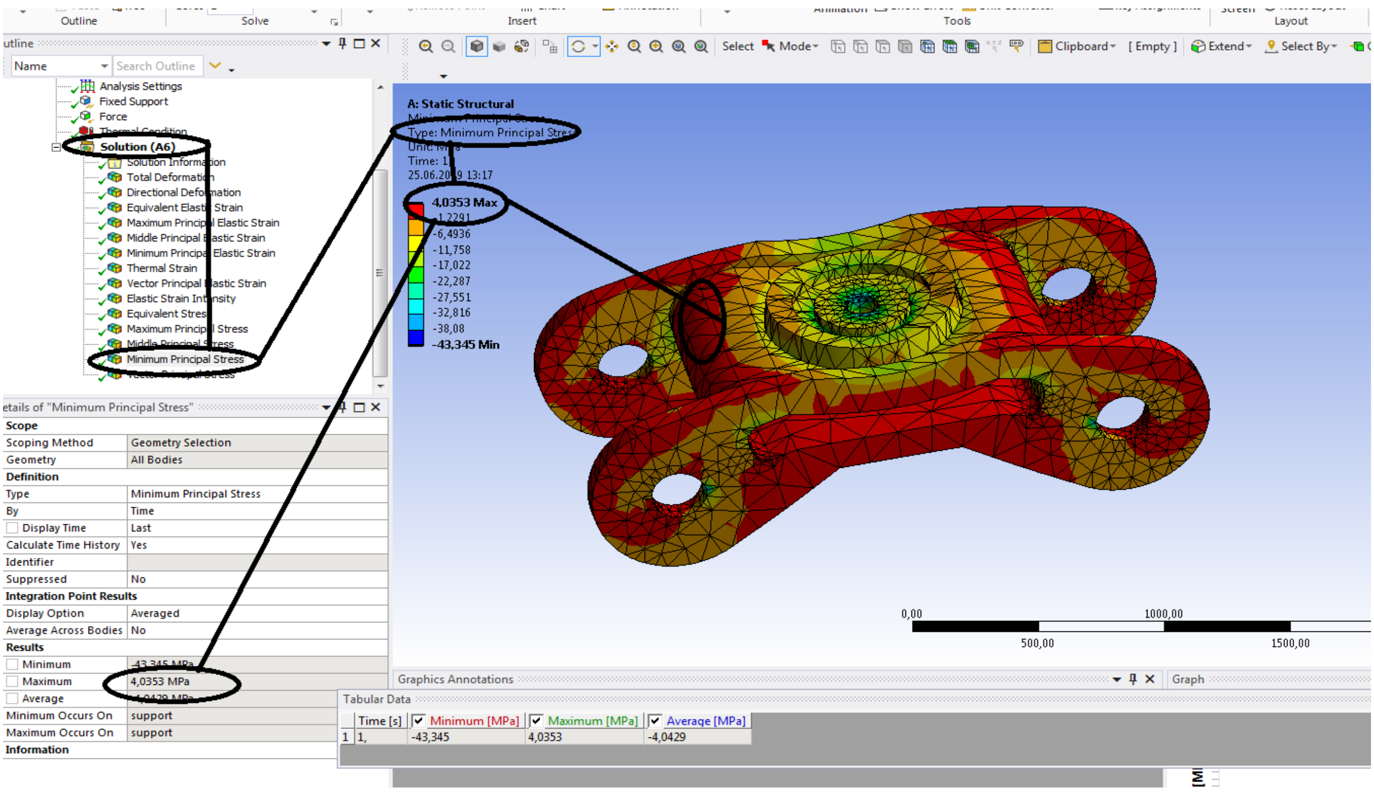


Figura 95 -Tensiunile principale $\sigma 3$ [MPa]

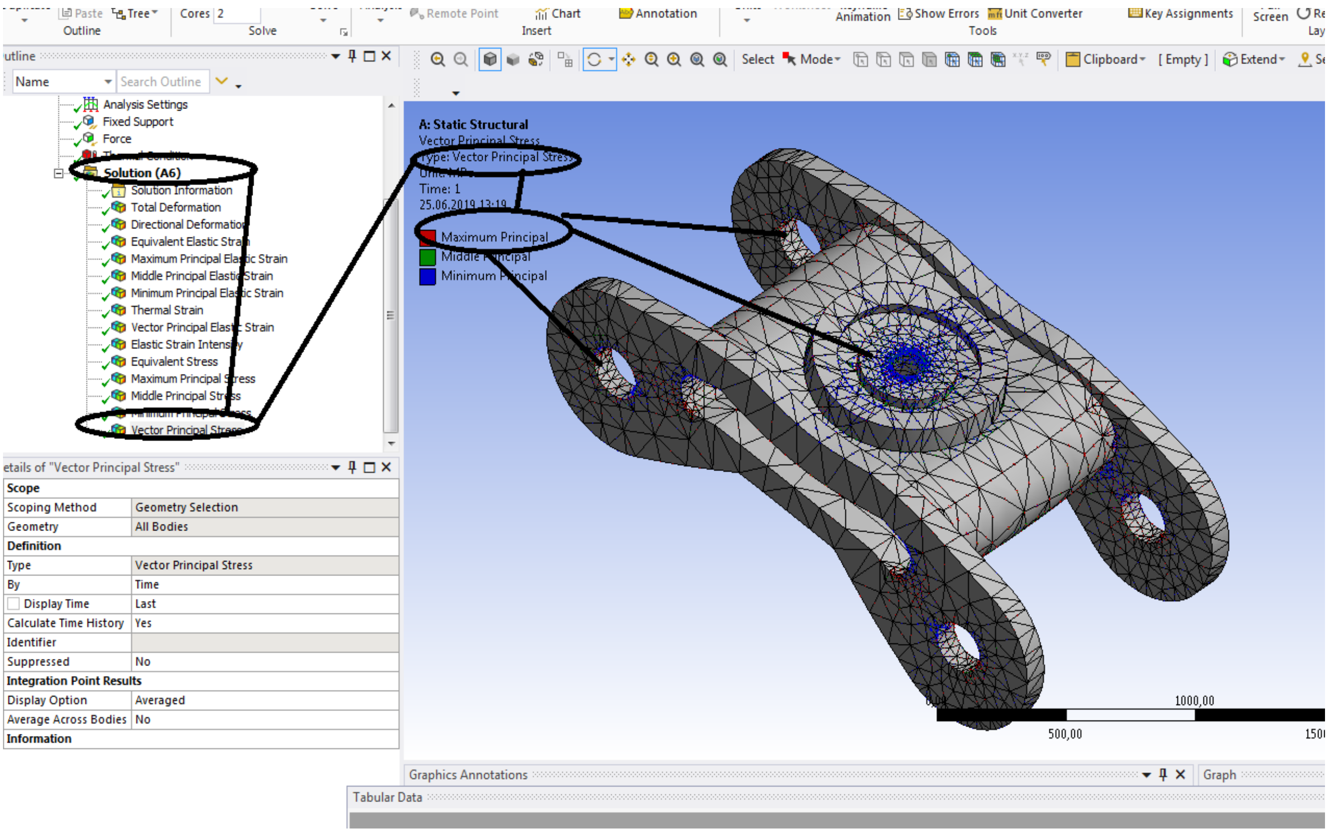


Figura 96 - Vectorii principali ai tensiunii

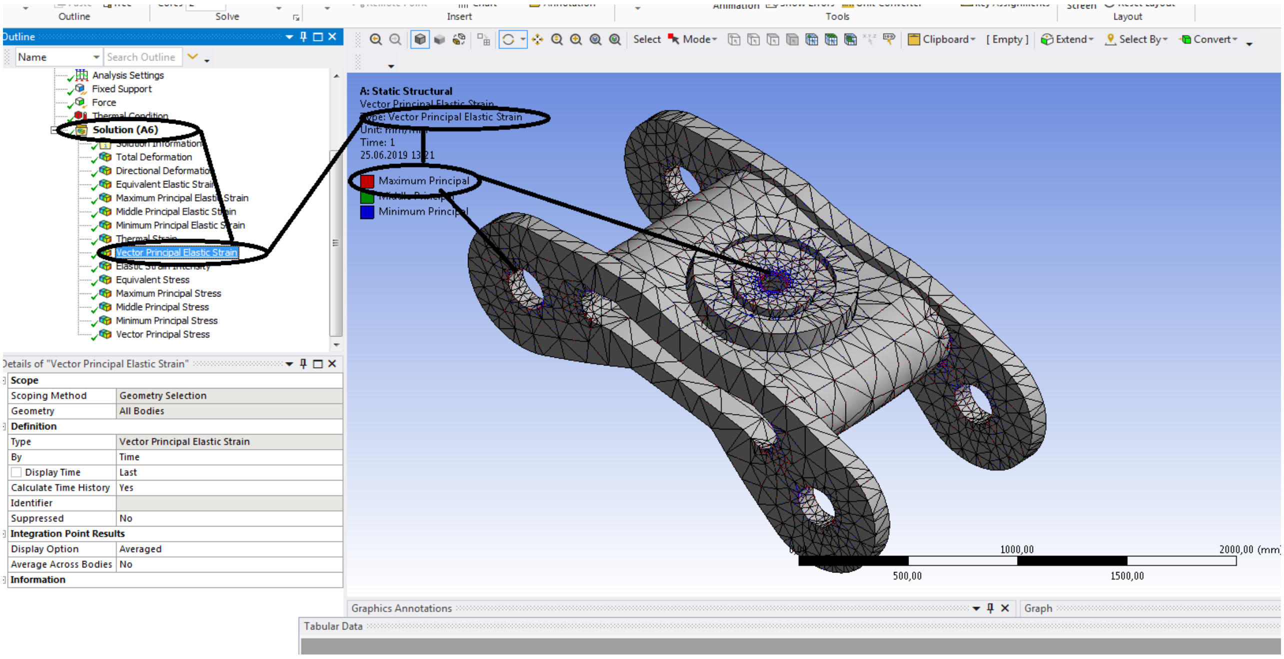


Figura 97 - Vectorii principali ai deformatiei specifice

1.7 Solicitari variabile –Oboseala - Boghiu

- **Se deschide Ansys Workbench;**
- **Se duce stanga la Static Structural, se da dublu clic pe Static Structural si apare casuta din dreapta A- Static Structural;**
- **Se da clic dreapta pe Geometry-Import Geometry-Browse- apoi ma duc la Boghiu in format IGS si dau clic dreapta**

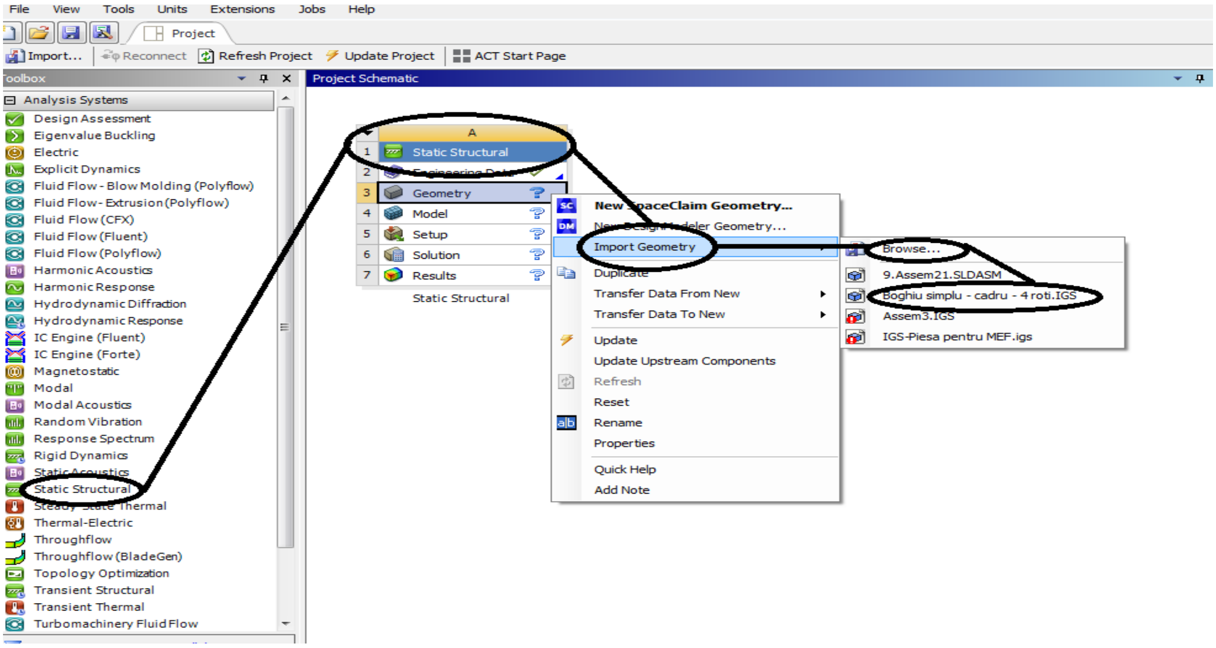


Figura 98 – Static Structural –Geometry- Browse- Boghiu IGS si clic

Se da clic pe boghiu- IGS si a luat geometria boghiului;

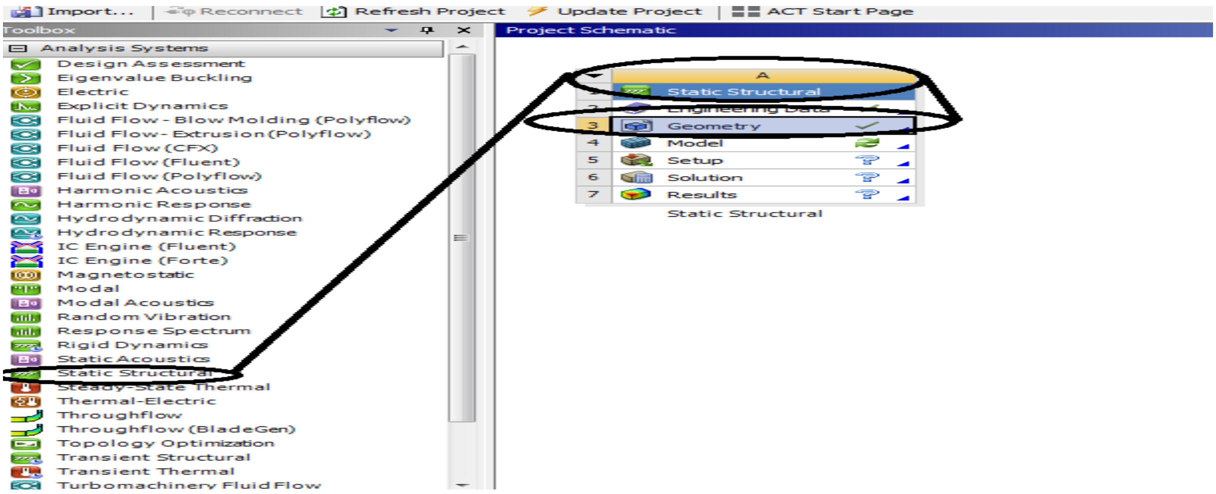


Figura 99 – Static Structural –Geometry- Browse- Boghiu IGS si clic- Geometria este luata

- se da dublu clic dreapta pe Model si se deschide Mechanical Ansys – Mechanical Enterprise;

- Project-Model – Static Strctural A5 -SolutionA6

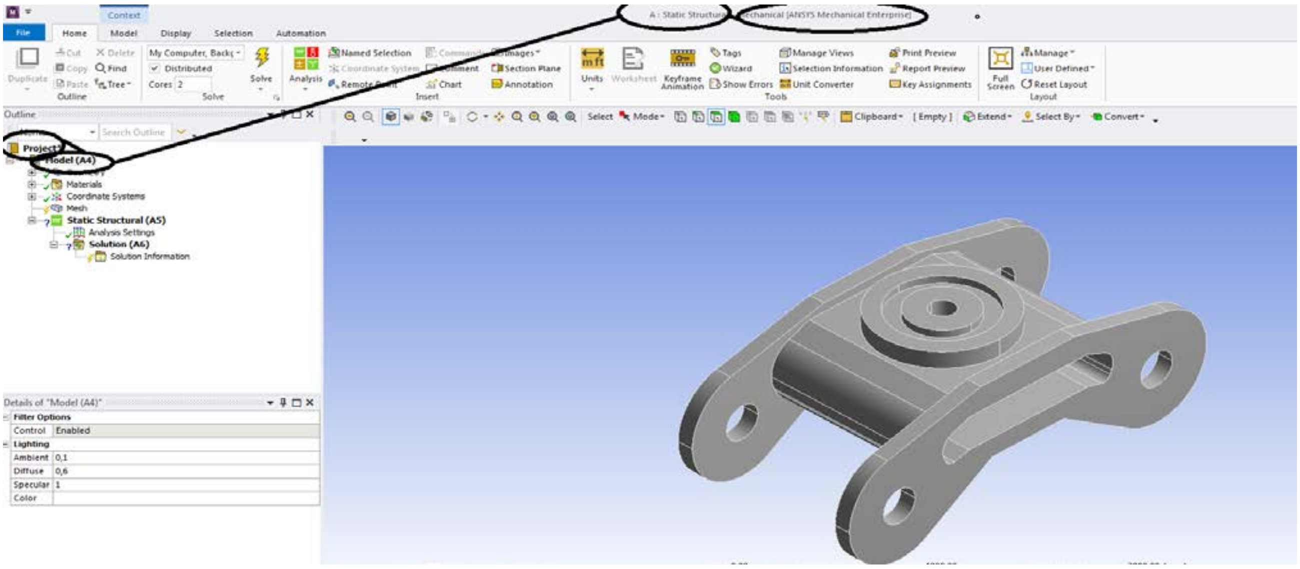


Figura 100 –- Project-Model (A4)

De aici se da discretizarea - in Static Structural se da rezemarea si incarcarea, se da Solution A6 cu: deformatii totale , axiale , deformatii specifice , tensiuni normale echivalente si principale;

-s-a facut discretizarea ;

- in Static Structural- insert-presiunea de incercare in MPa(presure);

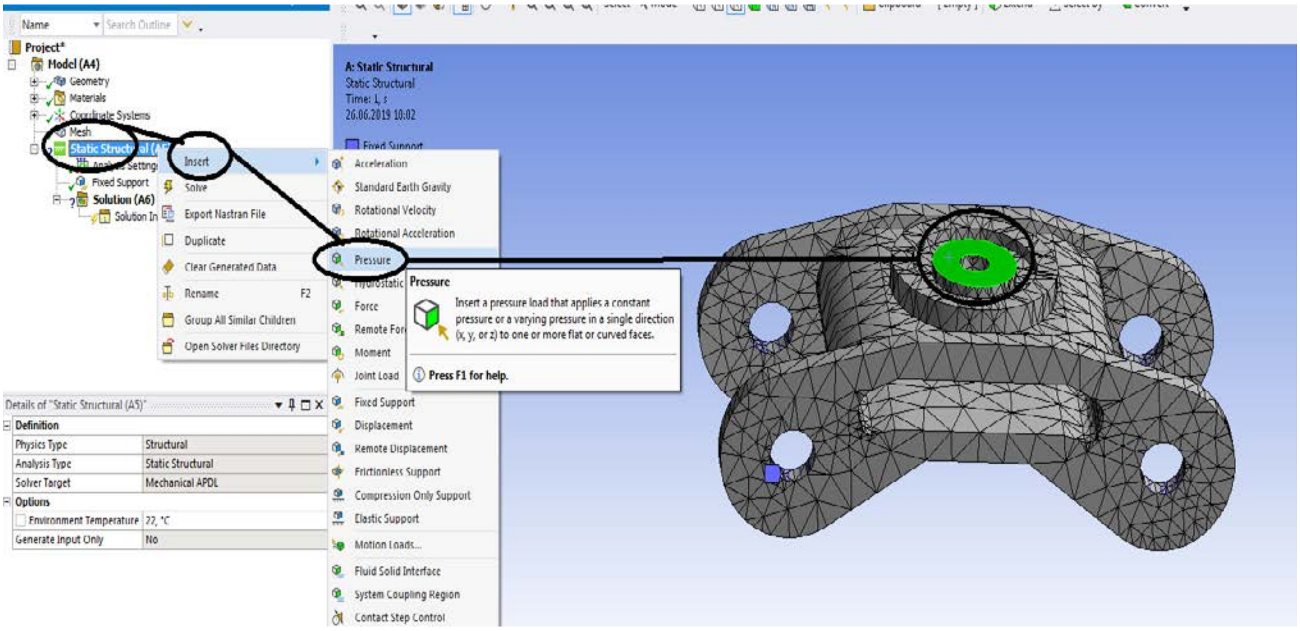


Figura 101–- Project-Model (A4)- Disctretizare (Mesch)

- **Se da clic pe presiune (presure) si apare casuta de dialod din stanga jos-Detalii presiune unde se pune valoarea presiunii de incercare;**

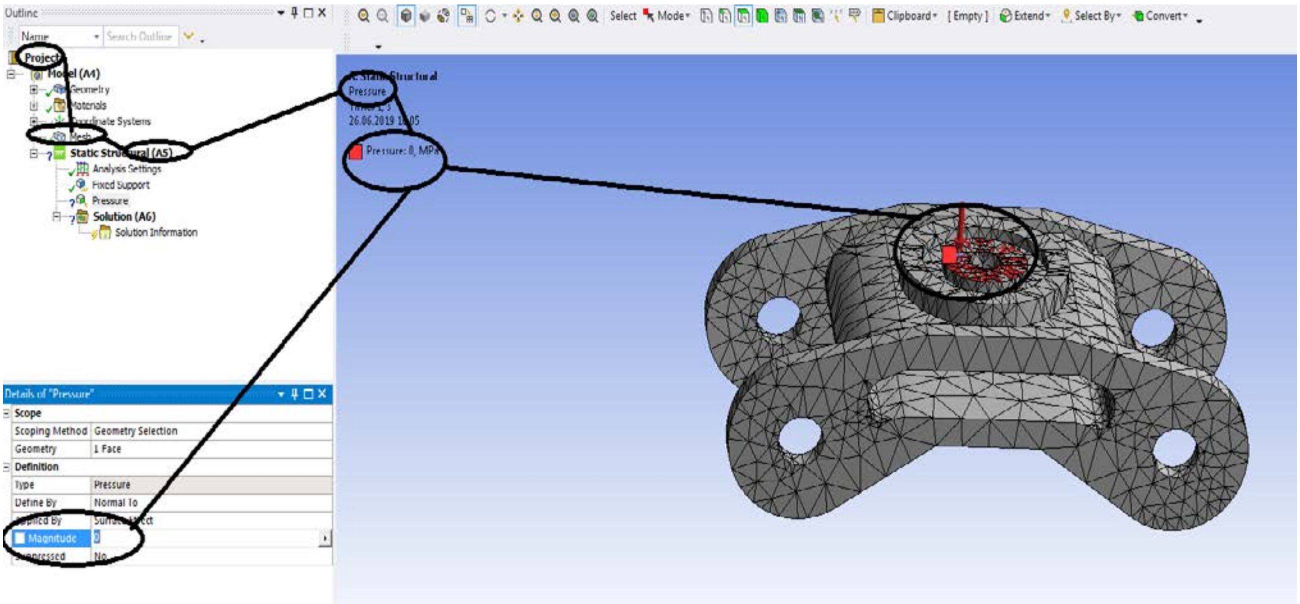


Figura 102–- Project-Model (A4)-Static Structural (A5) – Insert - Pressure

Se da o valoare de 32 MPa si se da Enter, valoarea este pusa si apare ca valoare si ca sens;

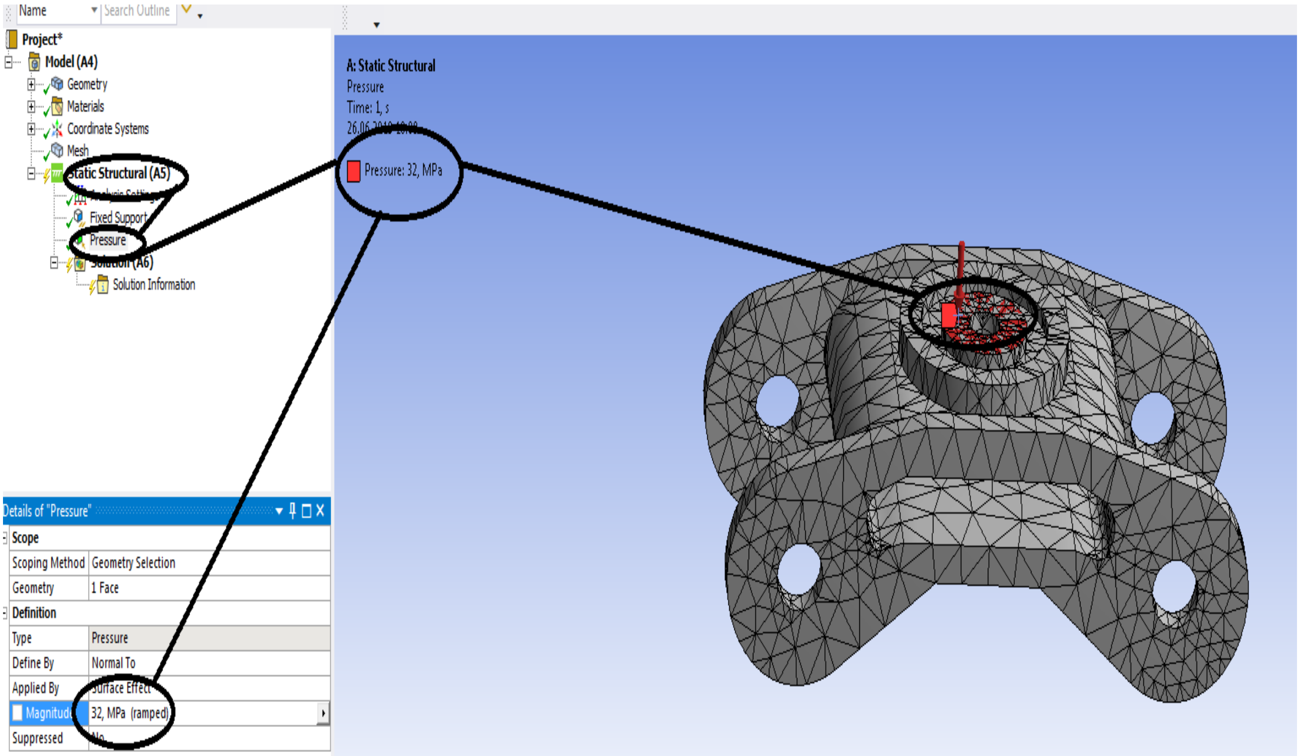


Figura 103–- Project-Model (A4)-Static Structural (A5) – Insert – Presiune (Pressure)

- **Se incarca cu un moment cu componentele dupa axele de coordonate;**

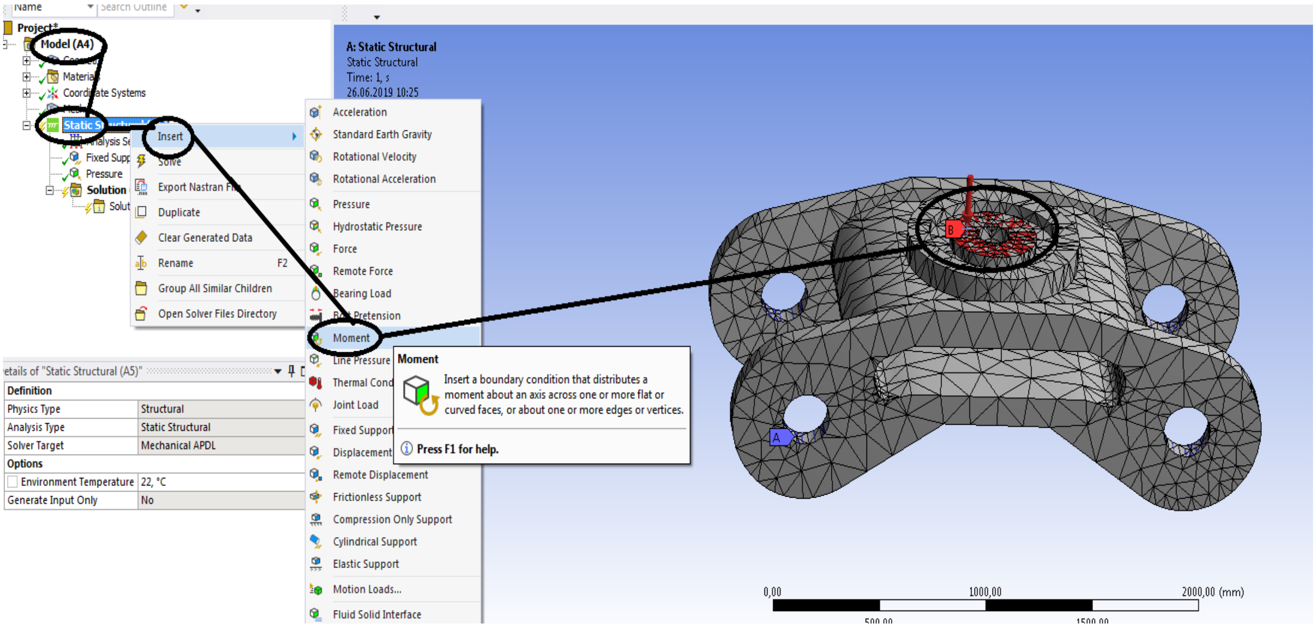


Figura 104–- Project-Model (A4)-Static Structural (A5) – Insert – Moment

-s-a dat clic pe moment si a aparut casuta de dialog din stanga jos;

-Trebuie sa fie aplicat momentul pe o suprafata a boghiului (applay);

- am ales suprafata boghiului;

- Momentul se defineste dupa componentele sale pe axele de coordonate;

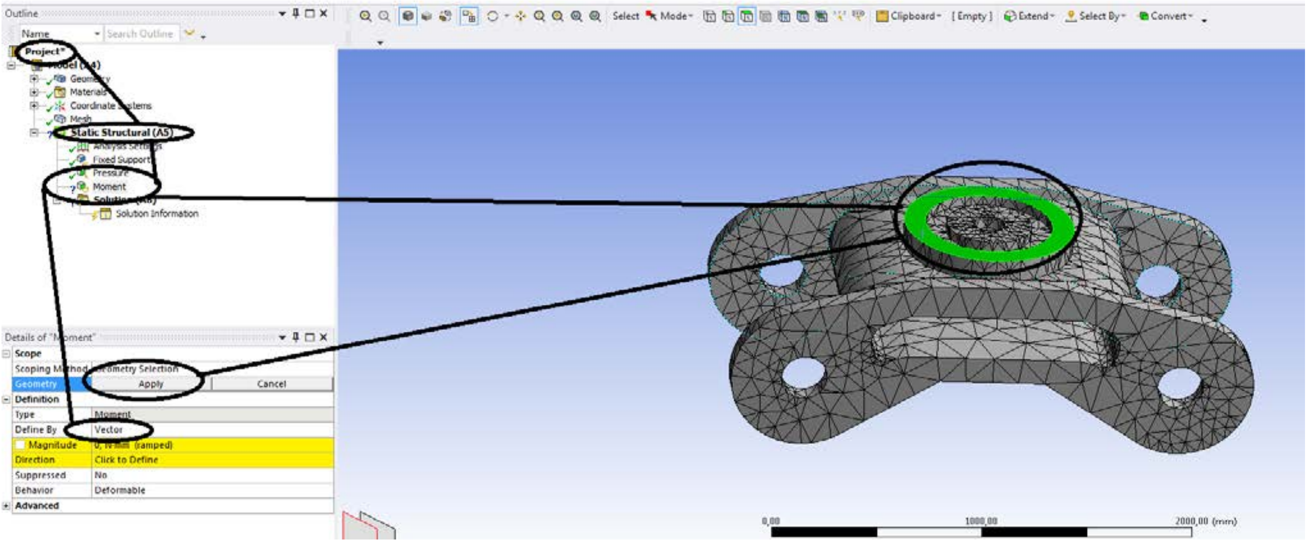


Figura 105–- Project-Model (A4)-Static Structural (A5) – Insert – Moment - Moment pe componente

- **Se da la vector spre componente ;**

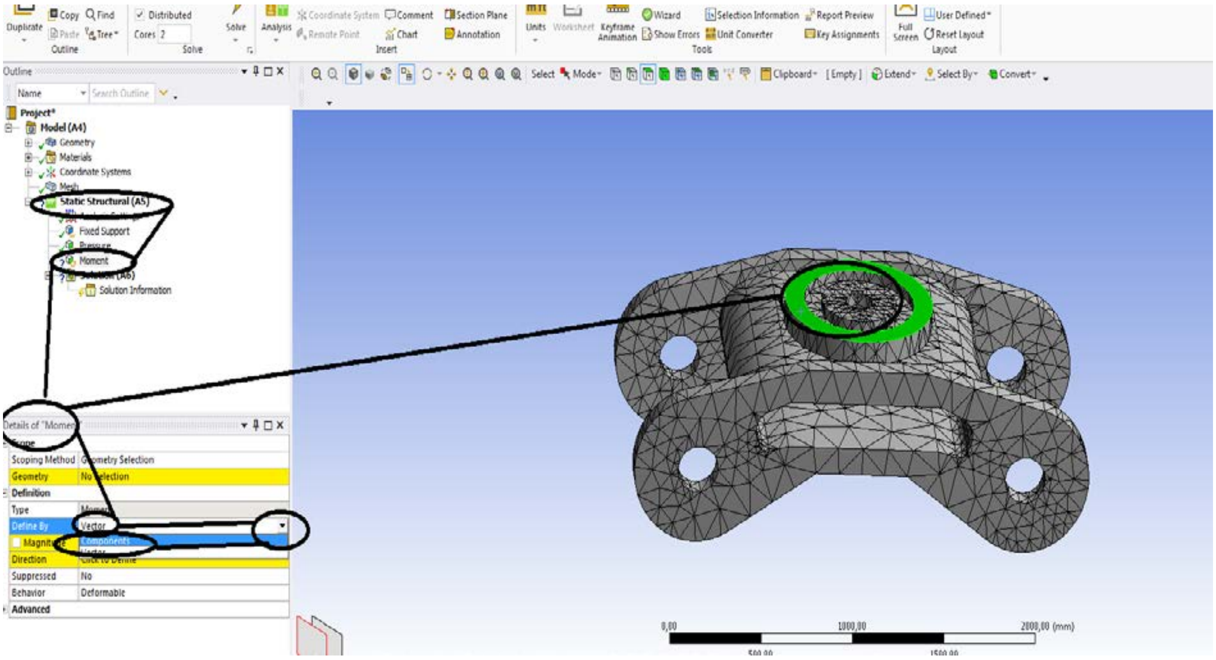


Figura 106–- Project-Model (A4)-Static Structural (A5) – Insert – Moment - Moment pe componente- apoi se da Enter

- **S-au pus componentele momentului, se va selecta geometria de incarcare pentru moment;**

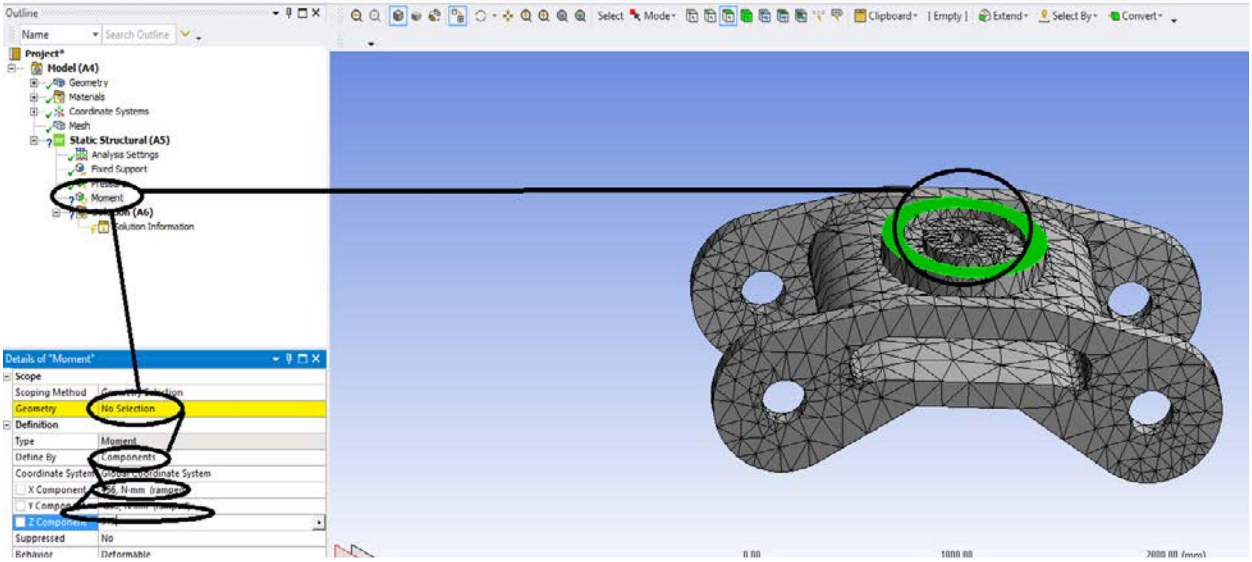


Figura 107– Project-Model (A4)-Static Structural (A5) – Insert – Moment - Moment pe componente- apoi se da Enter- Geometria pe care se pune Momentul

- **S-a pus suprafata de incarcare si valorile momentului;**

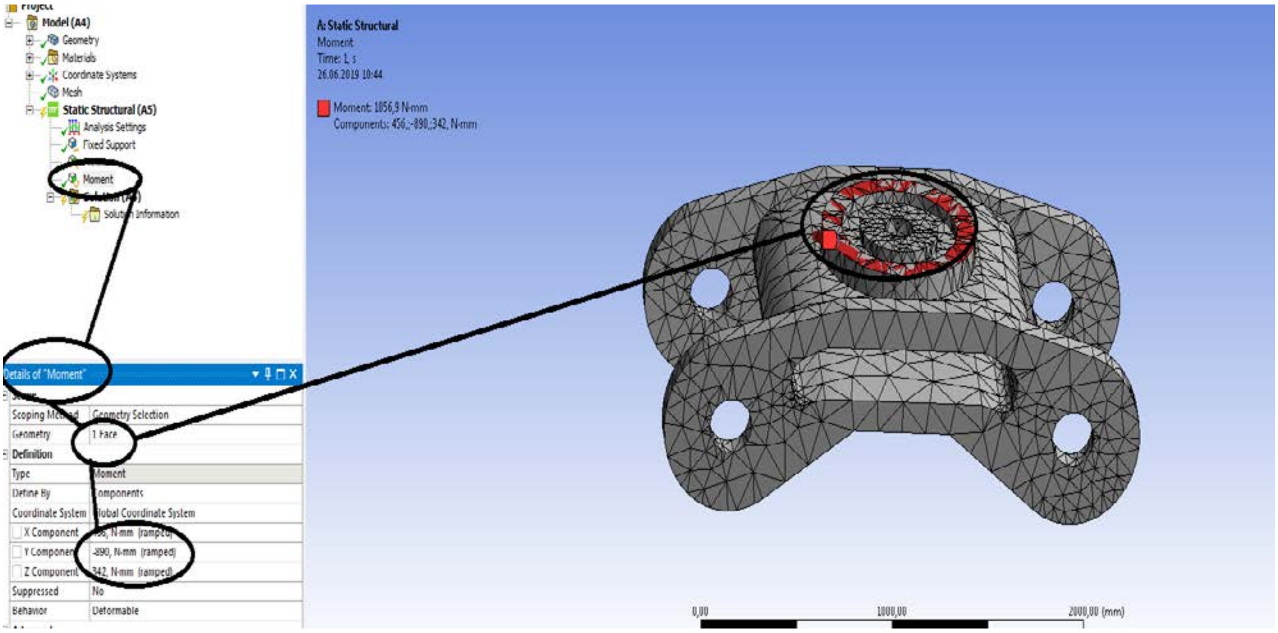


Figura 108 – Momentul si suprafata de incarcare

- **In solution A6 s-au pus conditiile si se da Solve pentru static structural mecanic;**

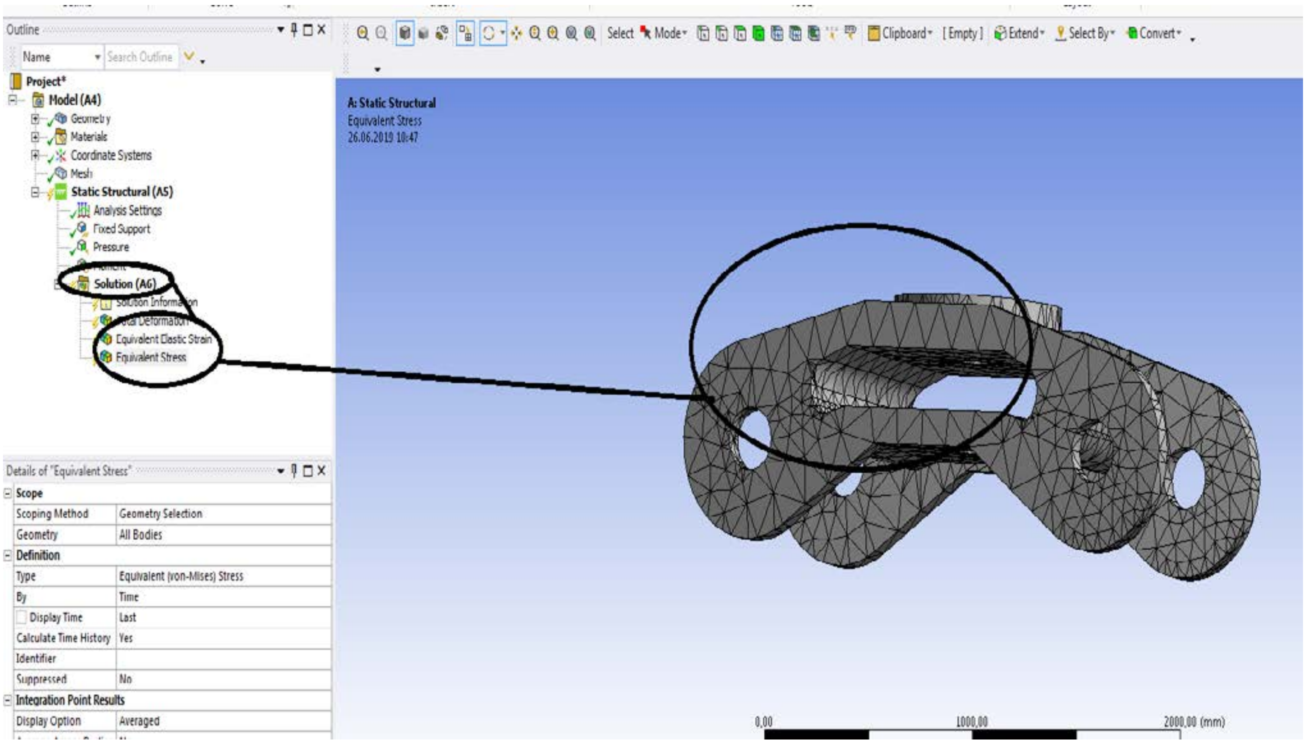


Figura 109 – Solution (A6)

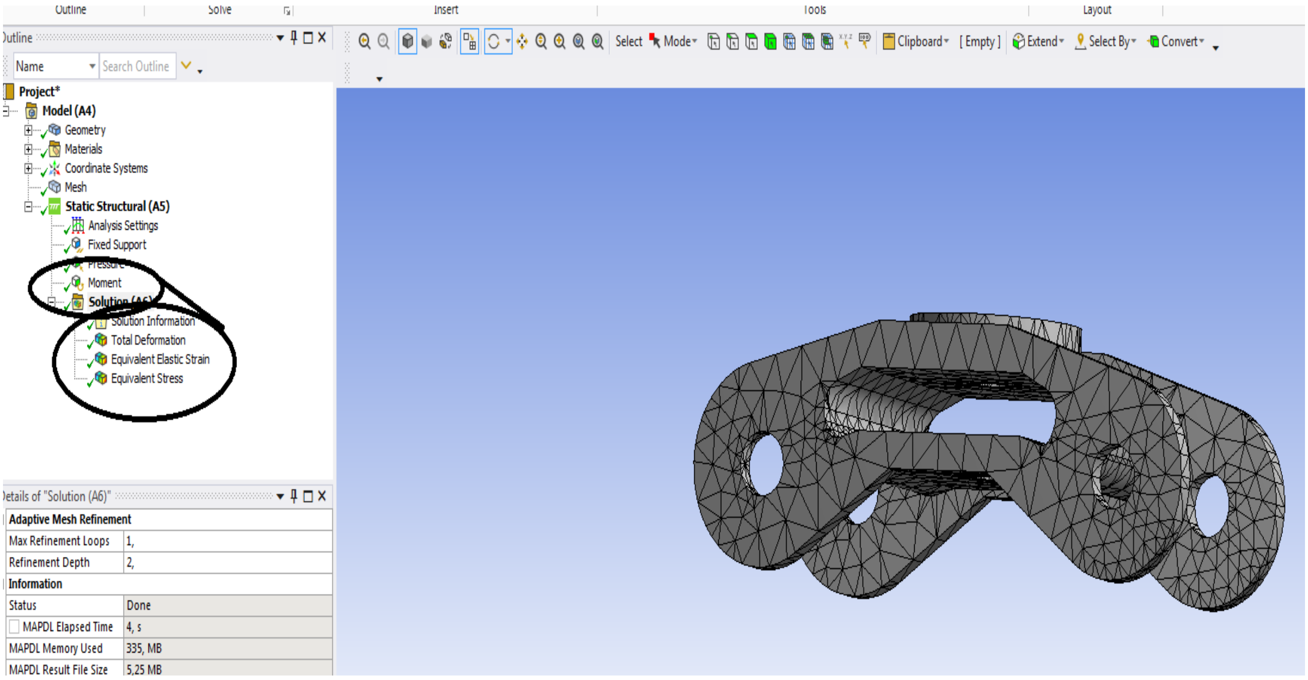


Figura 110– Solution (A6) - Insert- Stress – Deformations - Strains

<u>Solicitarea la oboseala pentru boghiu</u>

-Fatigue = oboseala

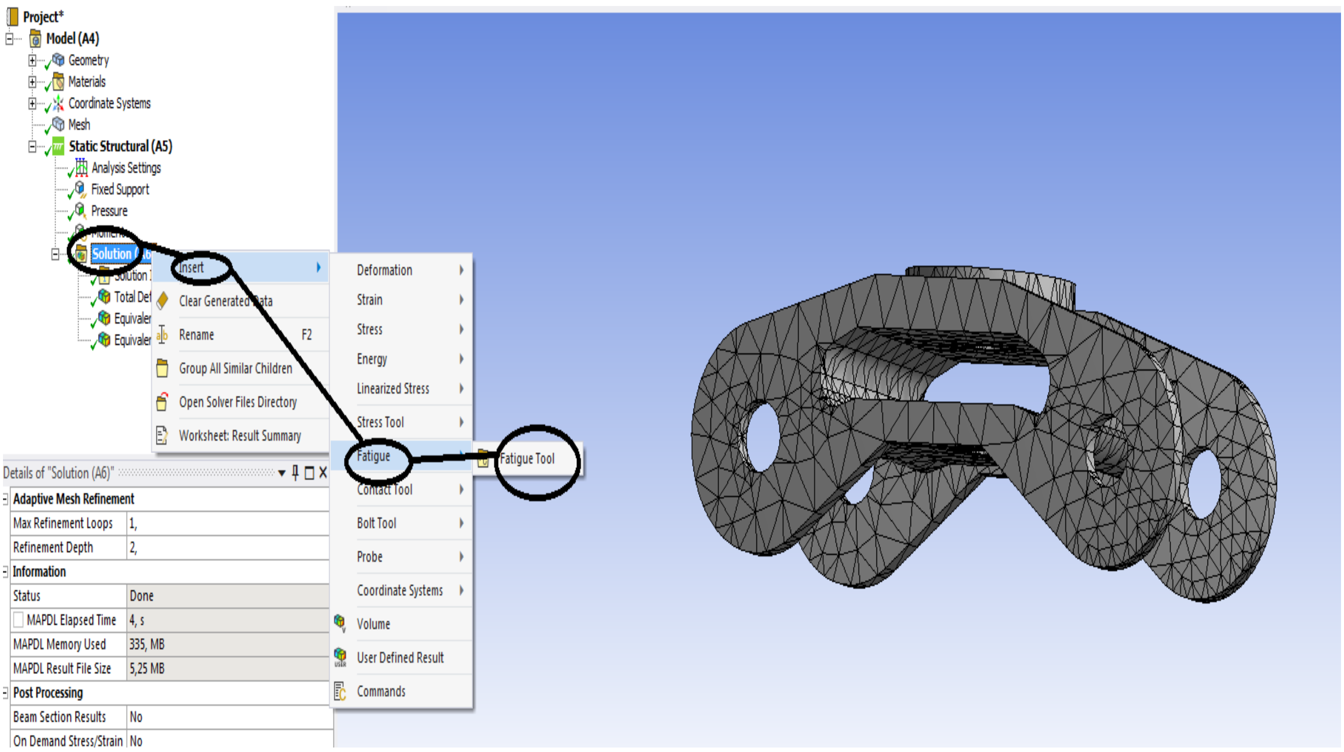


Figura 111 - De la Solution A6 – Insert-Fatigue – Fatigue Tool

- **Se da clic pe oboseala (Fatigue Tool) si apar;**
- **Se alege ratia (Ratio);**
- **Calculul coeficientilor de siguranta dupa anumite teorii;**
- **Ciclurile de incercare trebuie sa fie mai mari sau egal cu un milion;**

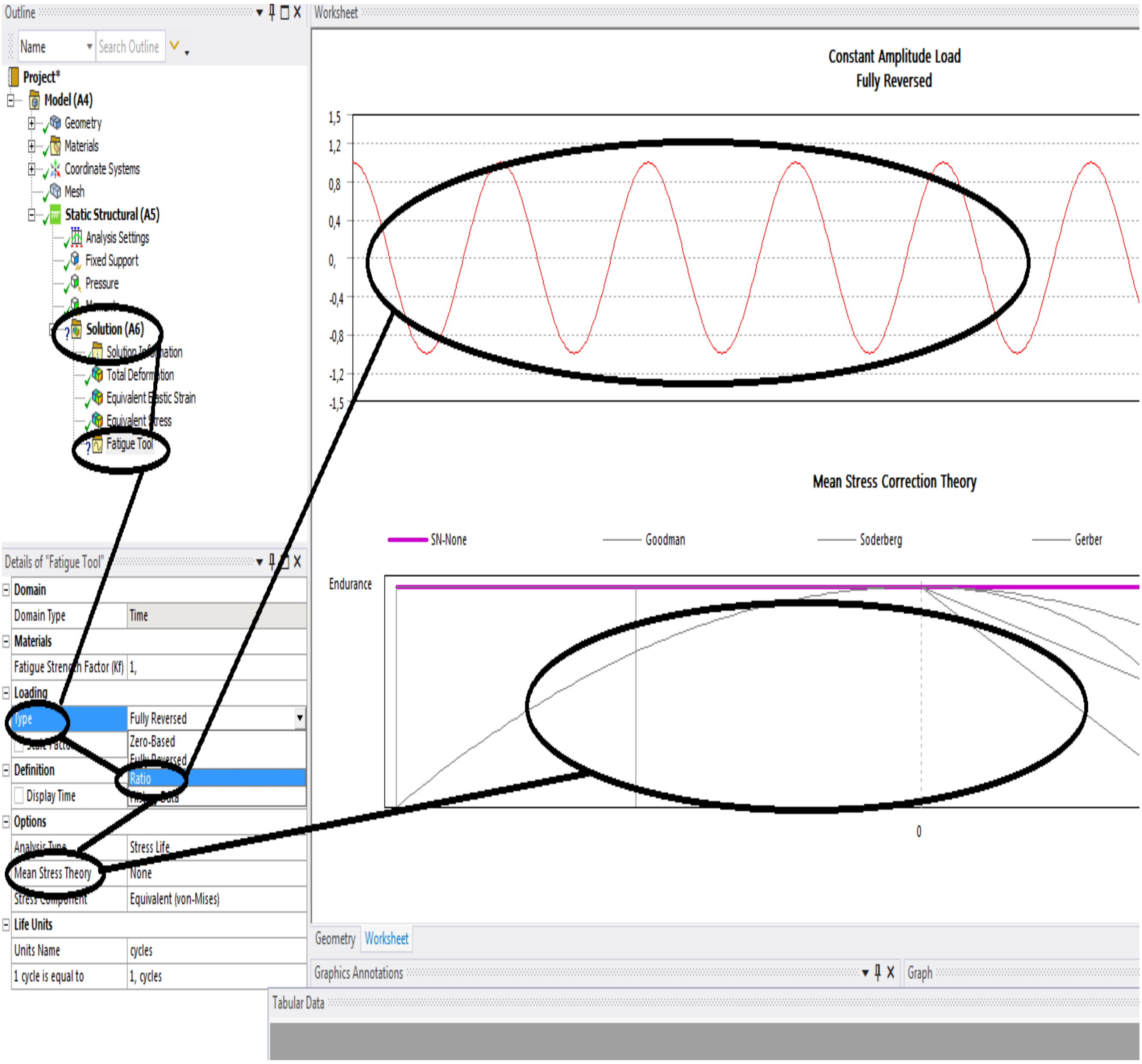


Figura 112 - De la Solution A6 – Insert-Fatigue – Fatigue Tool – Details of „Fatigue Tool”

-s-a ales ratia -1 , ciclu aternant simetric;

- se trece la alegerea caclcului coeficientilor de siguranta la oboseala;

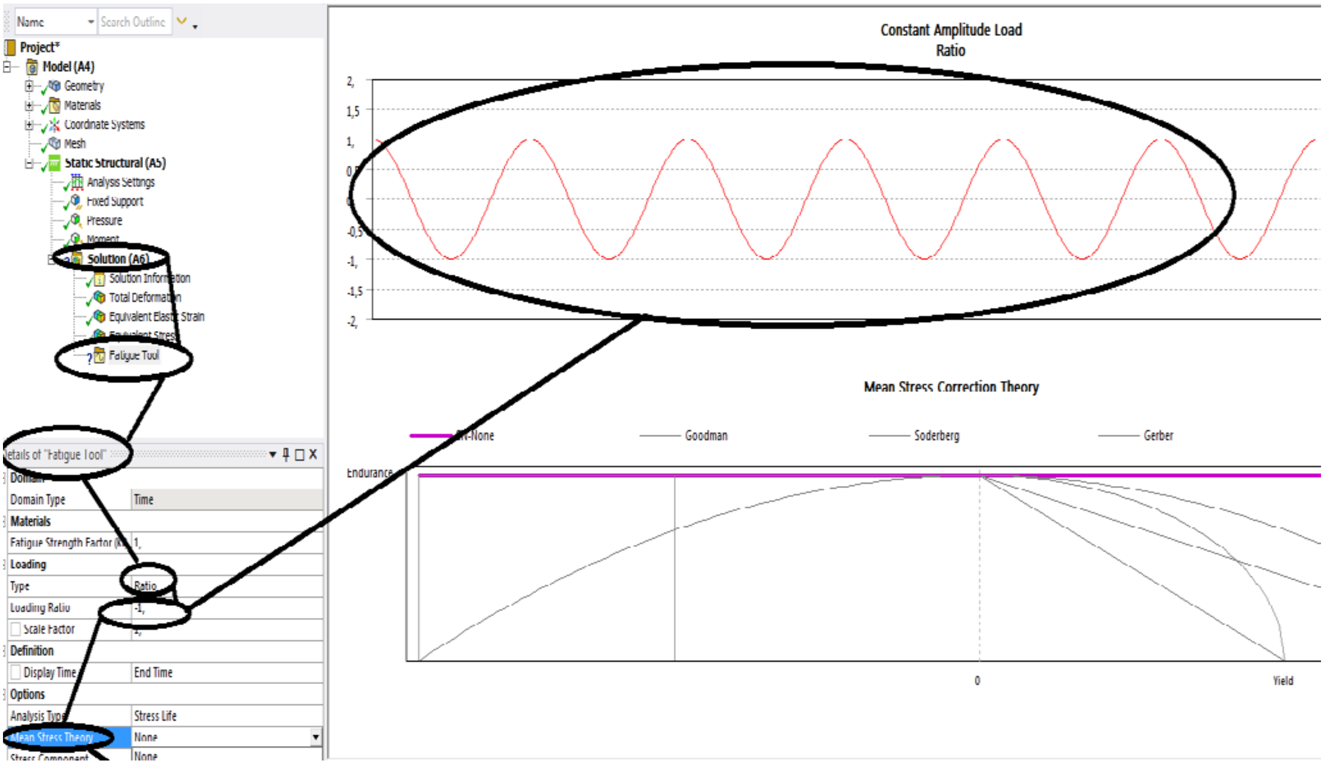


Figura 113 - De la Solution A6 – Insert-Fatigue – Fatigue Tool – Details of „Fatigue Tool”- se aleg parametrii

- se trece la alegerea caclculului coeficientilor de siguranta la oboseala si anume Soderberg

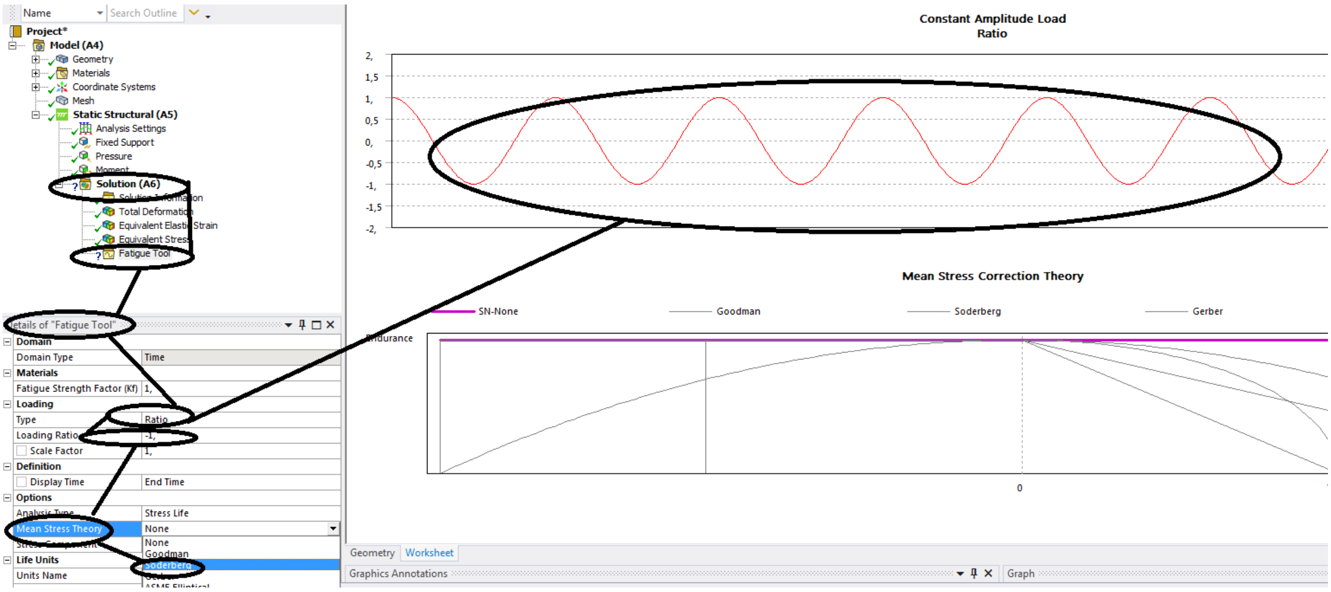


Figura 114 - De la Solution A6 – Insert-Fatigue – Fatigue Tool – Details of „Fatigue Tool”- se aleg parametrii si Enter

-R = -1 ;

-s-a dat clic dreapta pe Soderberg;

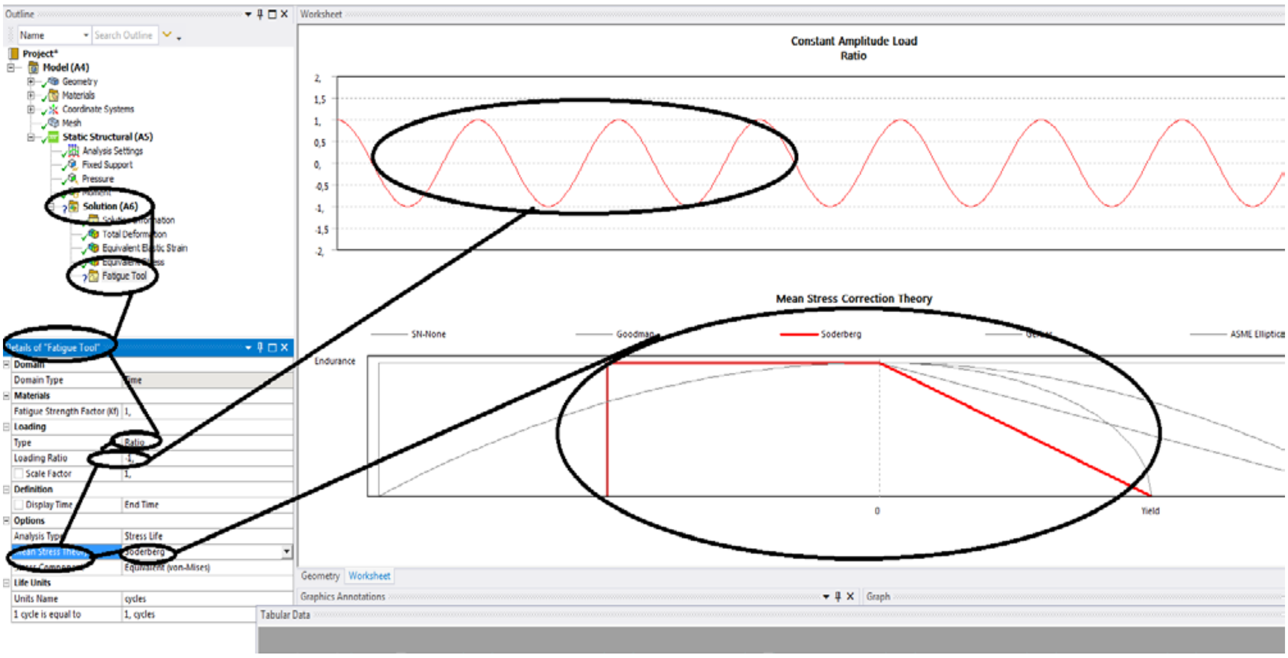


Figura 115 - De la Solution A6 – Insert-Fatigue – Fatigue Tool – Details of „Fatigue Tool”- se aleg Mean Stress Soderberg si Enter

- **Se pun 1000.000 de cicluri si se da enter;**

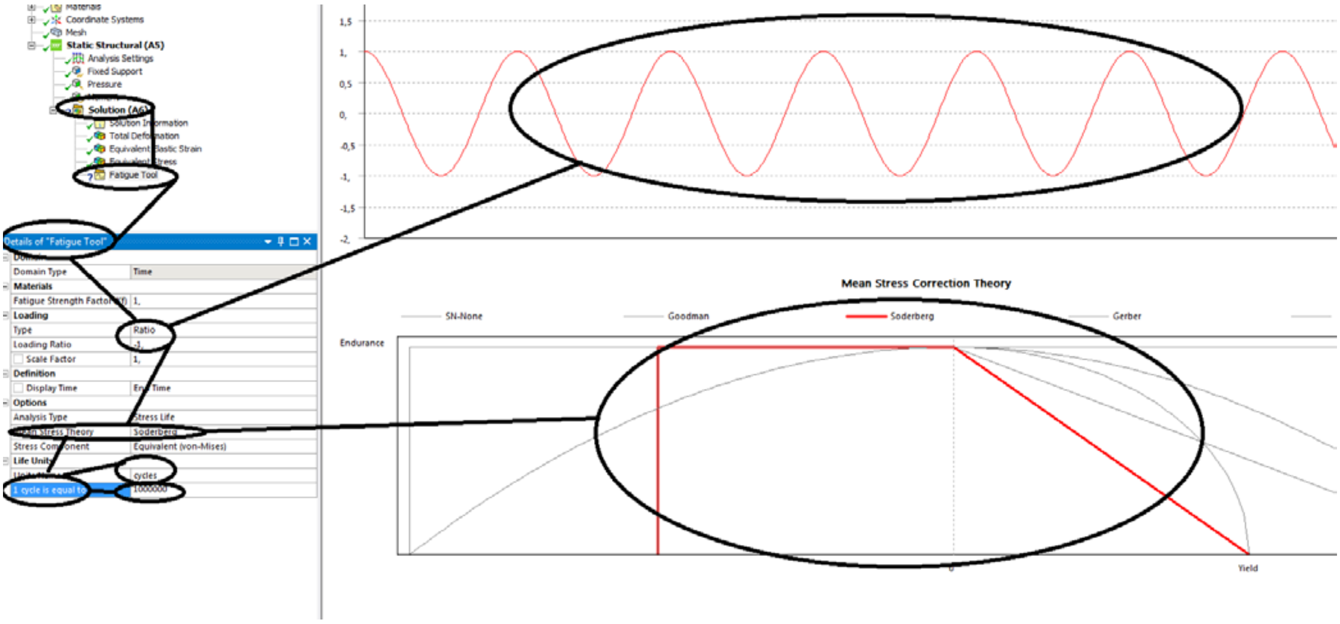


Figura 116 - De la Solution A6 – Insert-Fatigue – Fatigue Tool – Details of „Fatigue Tool”- se aleg Mean Stress Soderberg , numar de cicluri si R = -1 apoi Enter

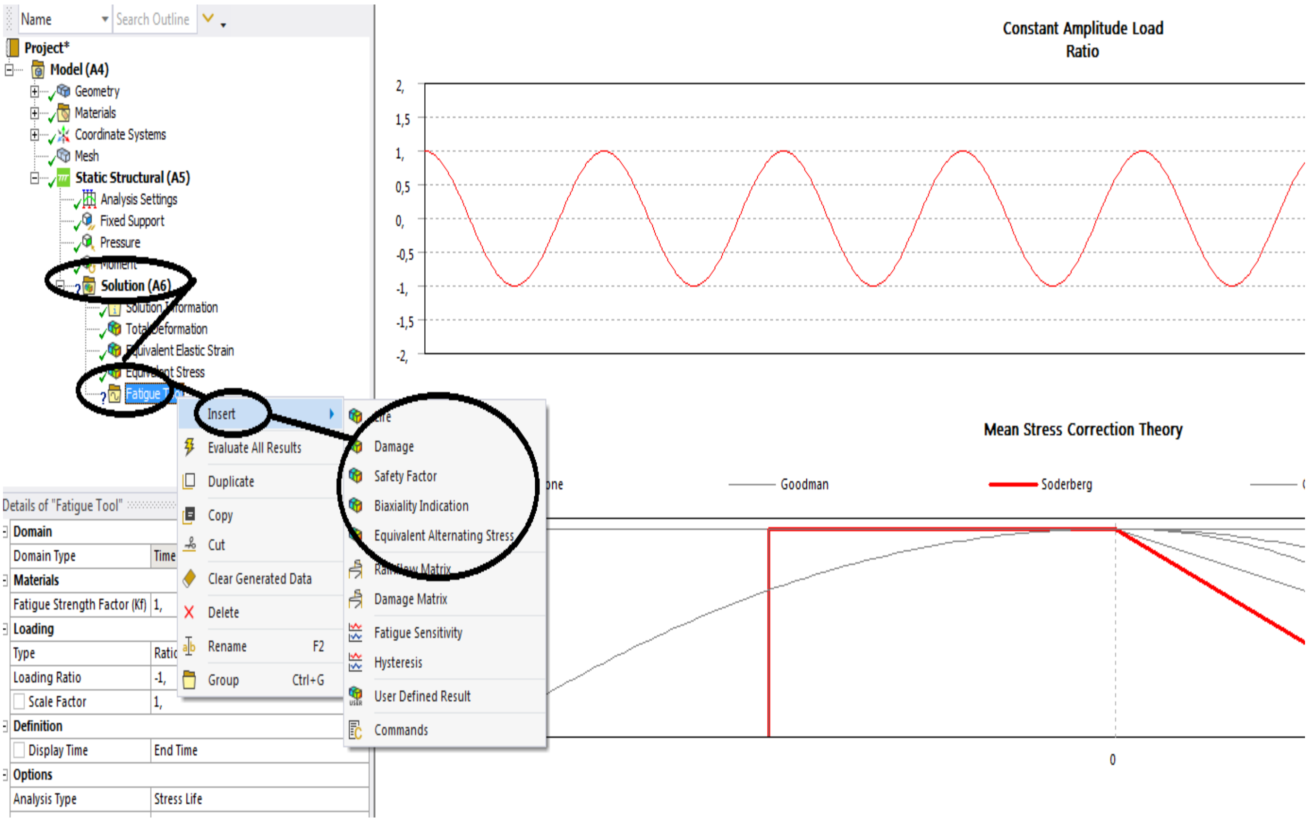


Figura 117 - Se duce la Fatigue-Insert- durata de viata (Life), avariile (Damage) , coeficientii de siguranta (safety factor) , tensiunea la oboseala(Echivalent Alternating Stress)

-Fatigue –Insert- Echivalent Alternating Stress si clic dreapta;

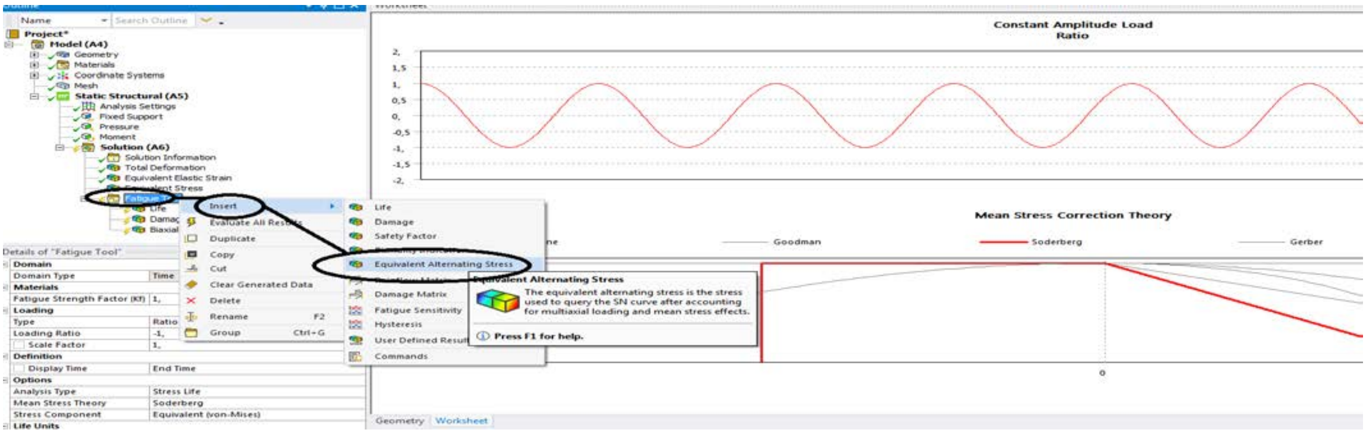


Figura 118 - Fatigue –Insert- Live, Damage, Safety Factor, Echivalent Alternating Stress si clic dreapta

- Safety Factor = coeficientul de siguranta;

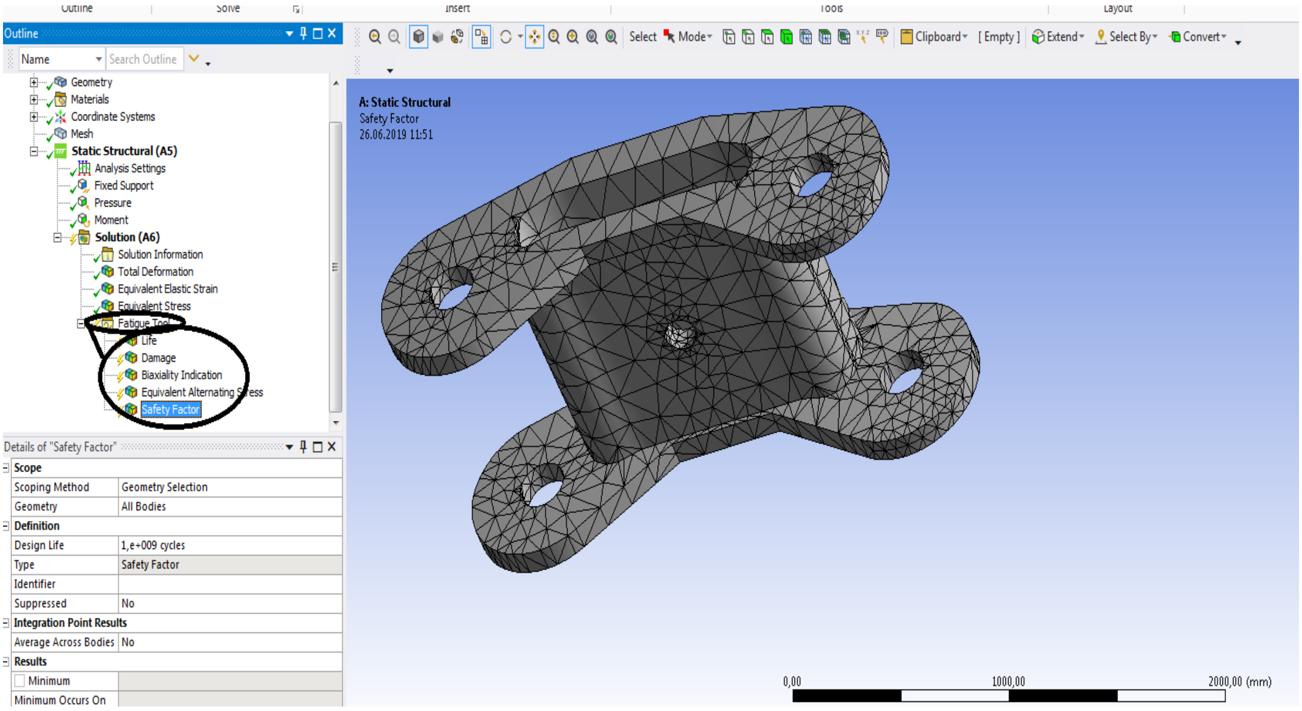


Figura 119 - Fatigue – Rezultate selectate

Fatigue –Insert- Evaluate All Results

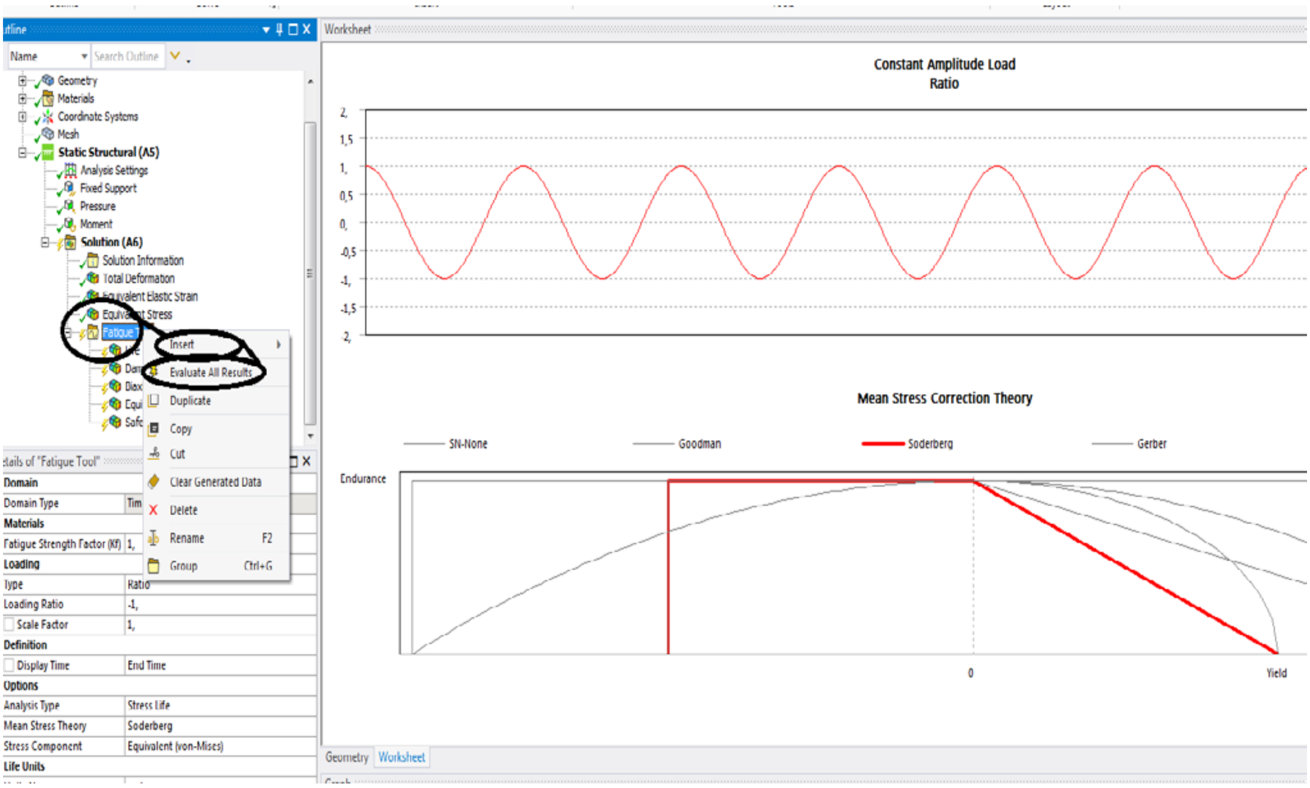


Figura 120 - Fatigue –Insert- Evaluate All Results si clic dreapta pe Evaluate All Results – Get Results si apar rezolvarile

1.8 Solicitarea la oboseala pentru boghiu - Rezultate

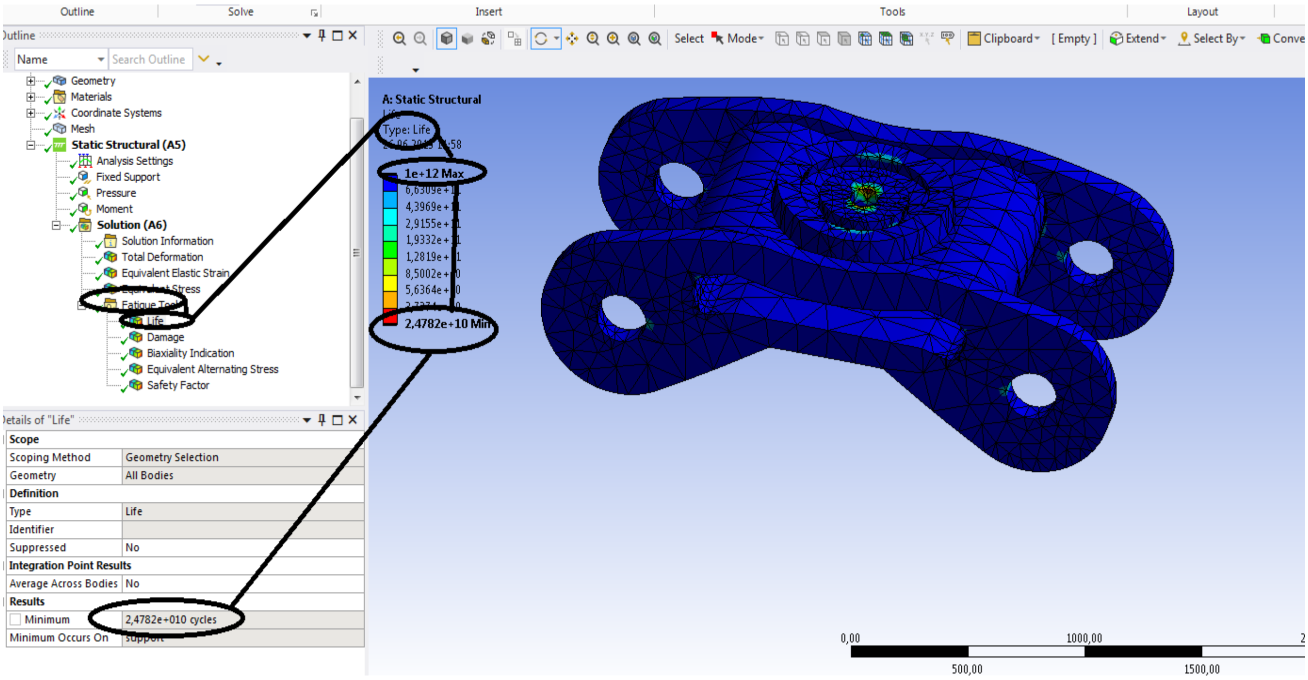


Figura 121 -Durata de viata [s]

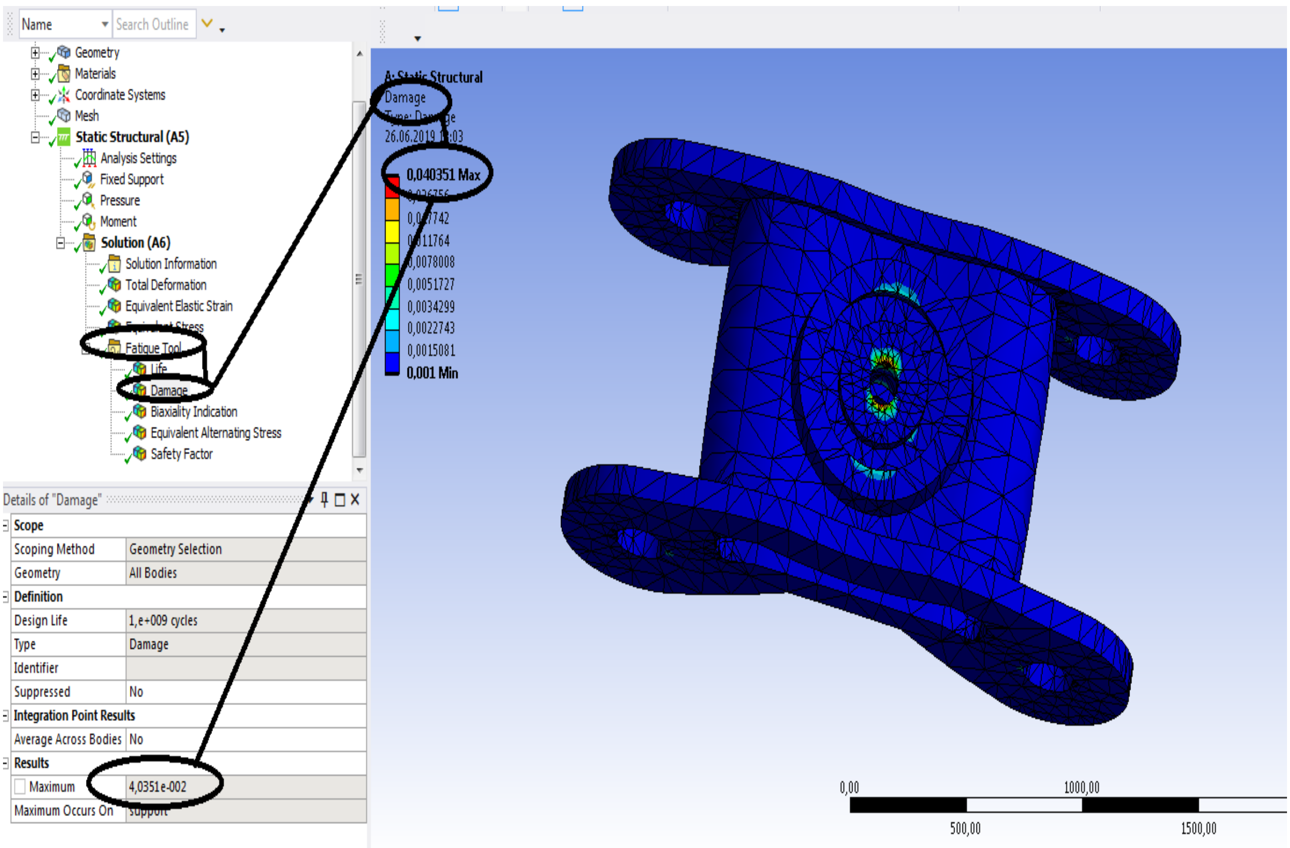


Figura 122 - Avarii [s]

R coeficientul de asimetrie (Biaxiality Indication)

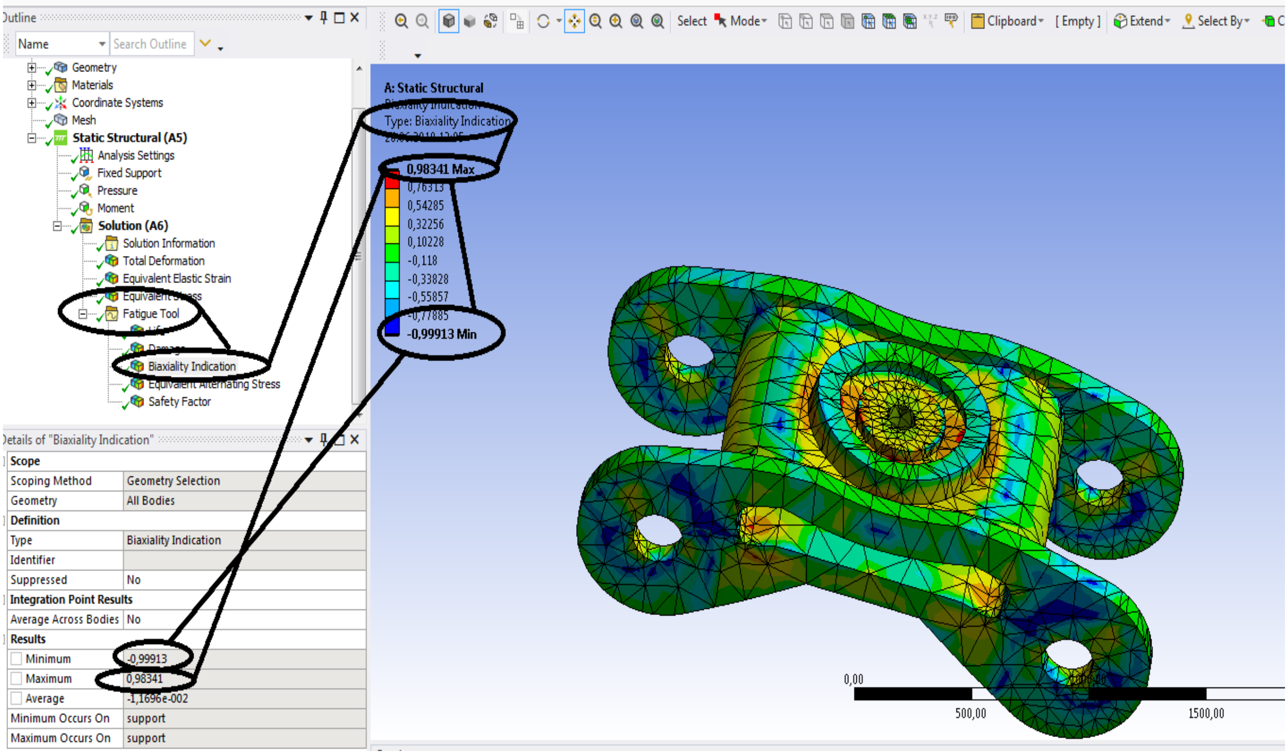


Figura 123 – (R) coeficientul de asimetrie (Biaxiality Indication)

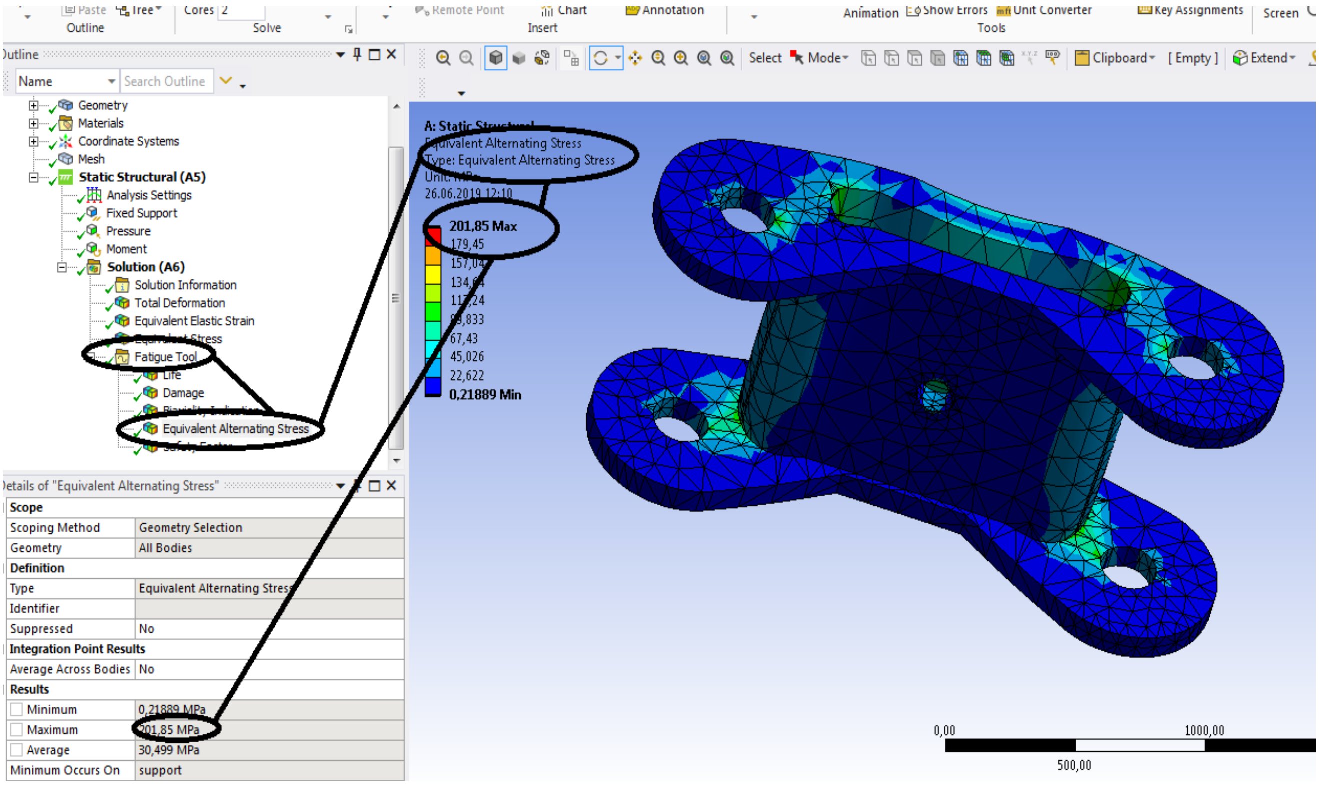


Figura 124 - Tensiunea la oboseala [MPa]

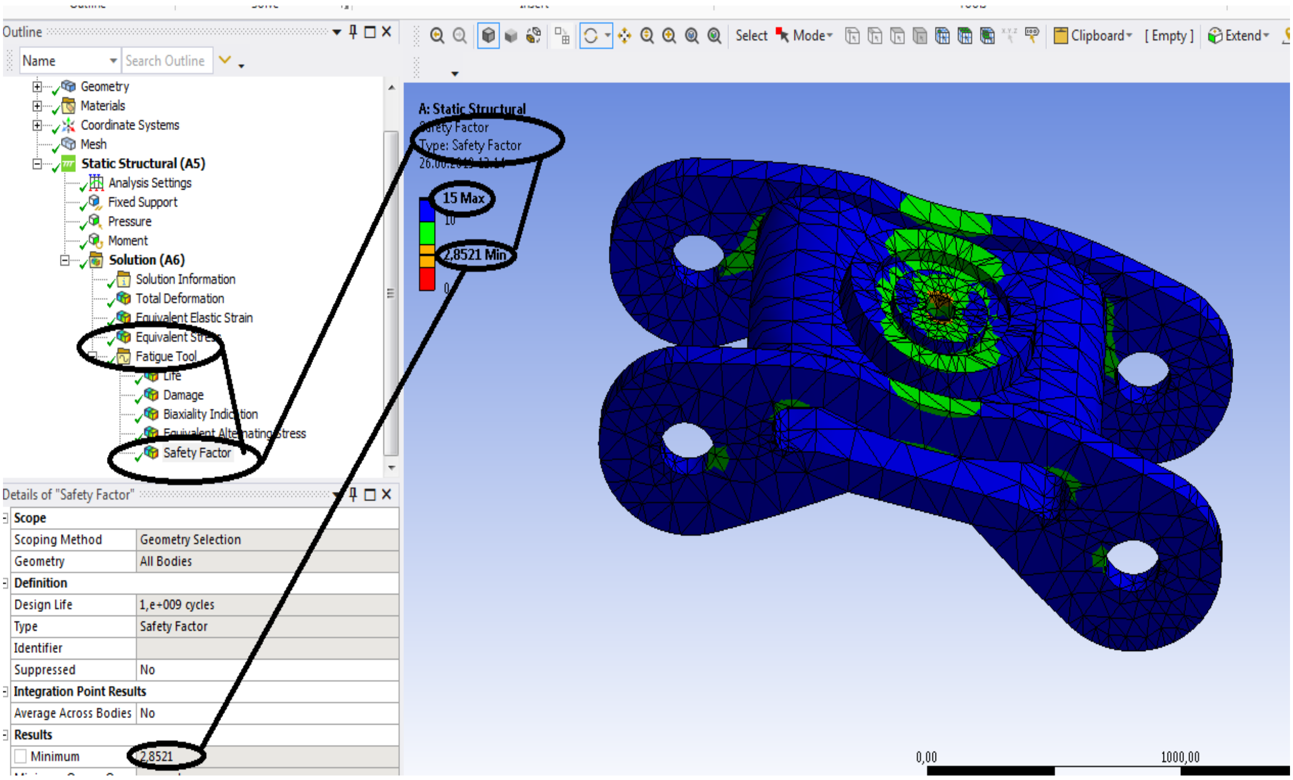


Figura 125 - Coeficientii de siguranta

1.9 Solicitarea la vibratii pentru boghiu

- **Se deschide Ansys Workbench;**

- se selecteaza Modal din partea stanga;

-Se da dublu clic pe Modal si apare casuta din partea dreapta;

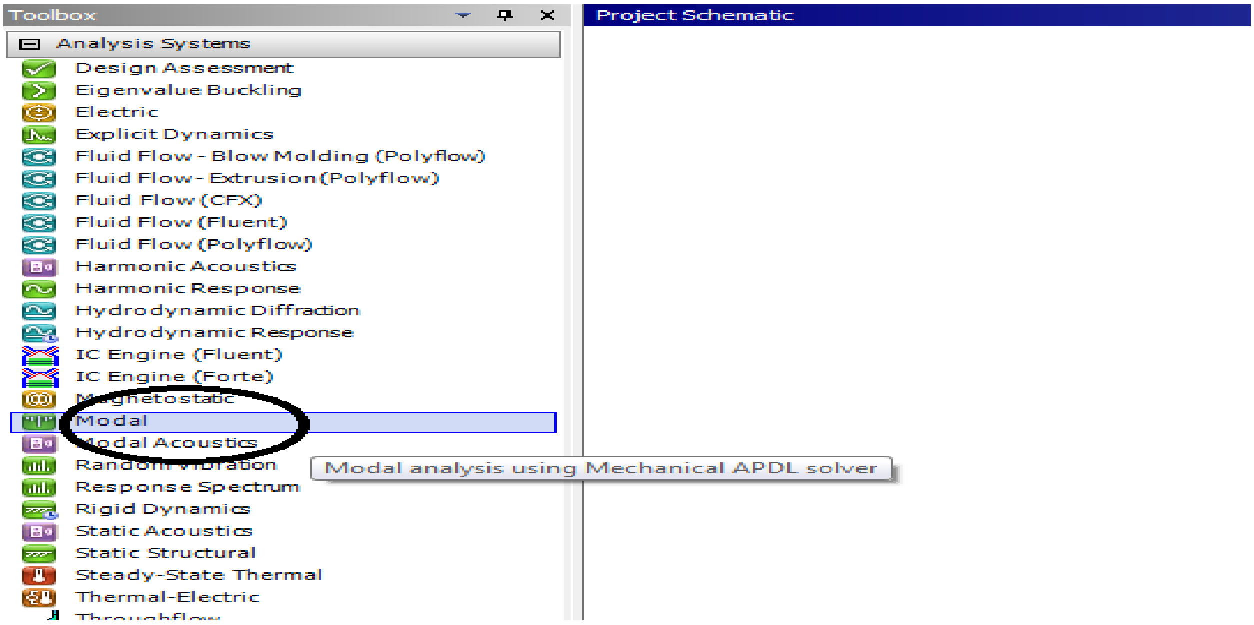


Figura 126 – Modal – apare casuta de la Project Schematic

De la solutii (Solution) – Transfer Data To New (transferati datele la noi)- Random Vibration (Vibratii aleatorii)

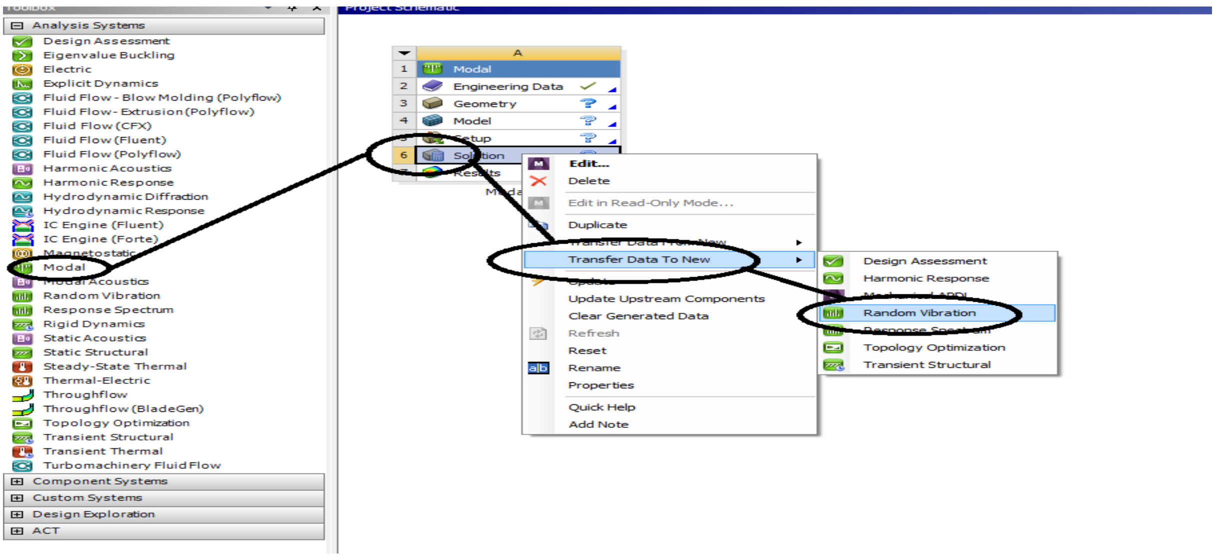


Figura 127 – Modal –Modal A - (Solution) – Transfer Data To New

(transferati datele la noi)- Random Vibration (Vibratii aleatorii)

-clic dreapta pe Random Vibration (Vibratii aleatorii) si se obtine;

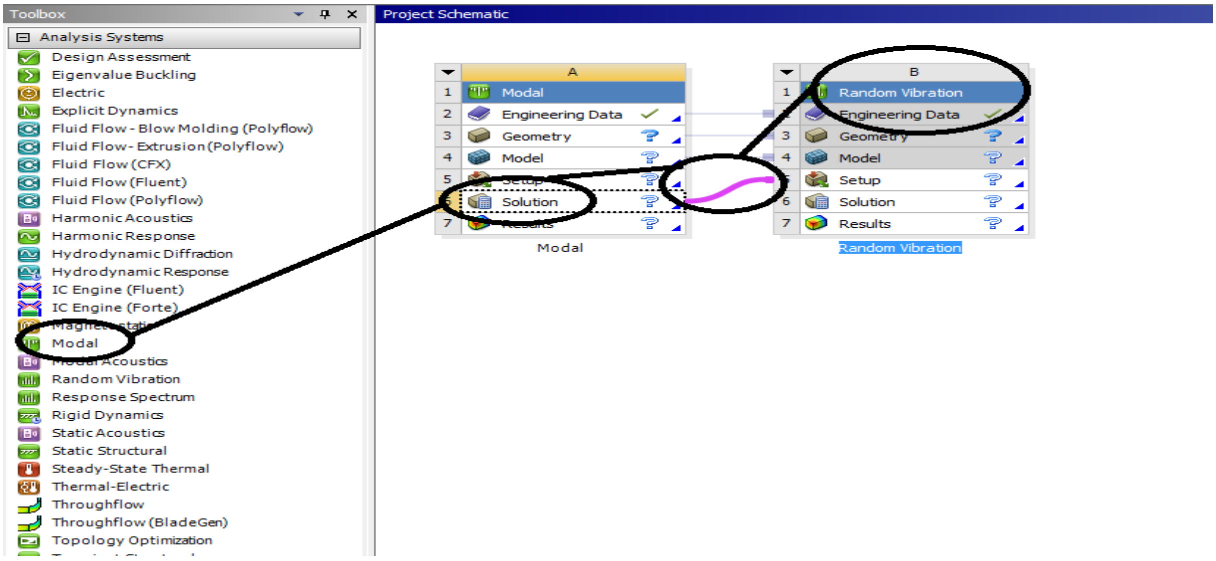


Figura 128 – Modal –Modal A - (Solution) – Transfer Data To New (transferati datele la noi)- Random Vibration (Vibratii aleatorii) casuta B

- **Se duce la casuta de dialog din dreapta fata , adica A;**
- **Din casuta din B nu se poate continua si am pus-o intr-un dreptunghi cu sageata;**
- **Din casuta dreapta A se merge la Geometrie (Geometry)-Import Geometry-Browse (Cauta) - Boghiu -IGS**

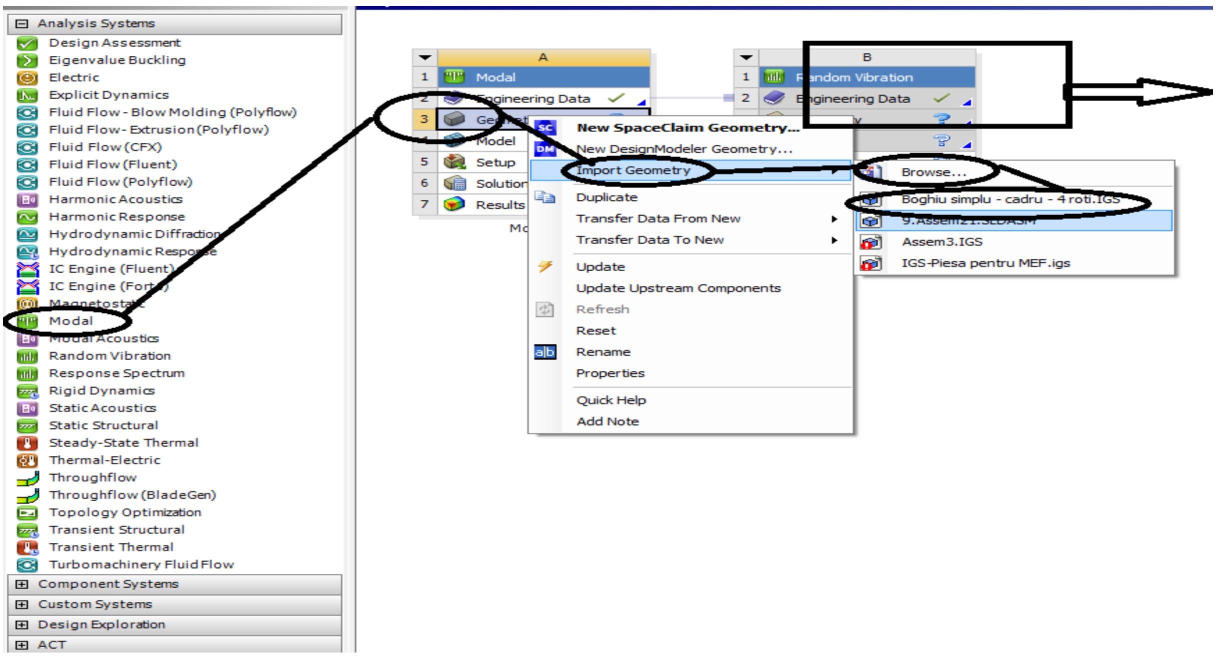


Figura 129 – Se transfera geometria in program

- **s-a dat clic pr boghiu cadru-IGS si au aparut legaturile negre dintre casute;**

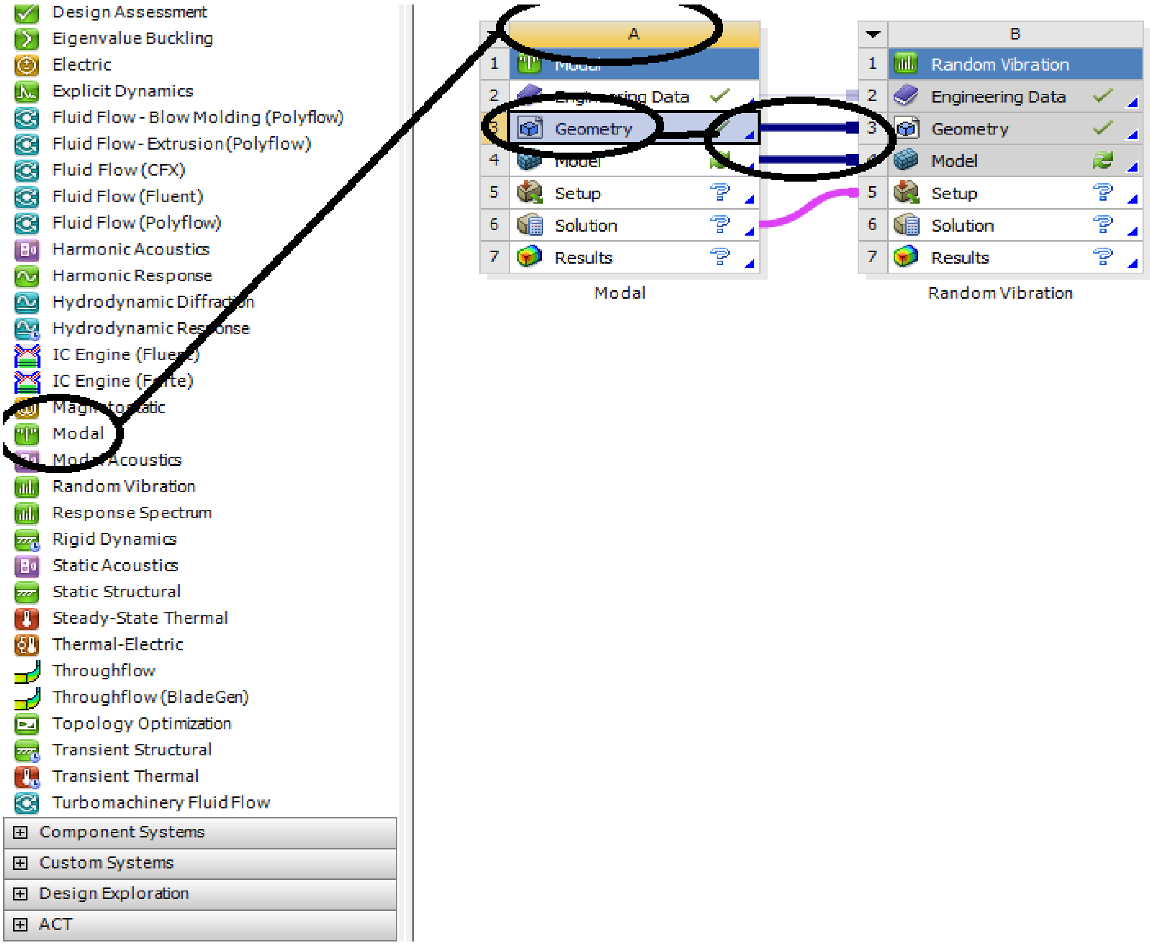


Figura 130 – Geometria trasnferata in program – se duce la Model

-Se da pe Model dublu clic dreapta;

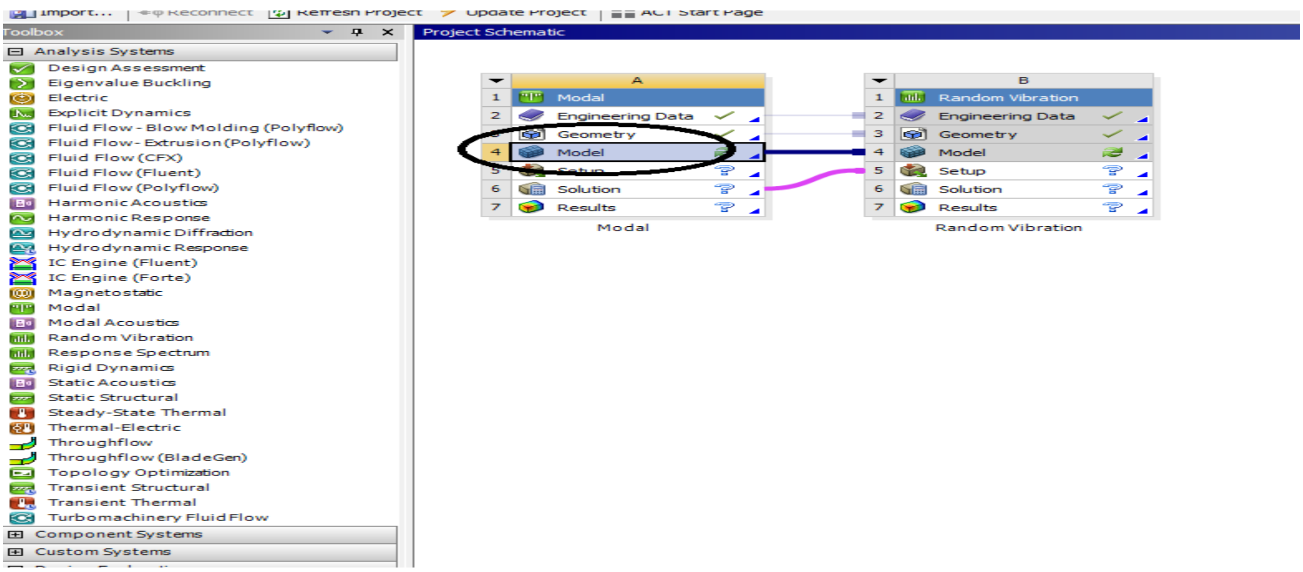


Figura 131 – Geometria trasnferata in program – se da clic pe Model

- **se intra in Multiple Systems –Mechanical (Ansys)-Mechanical Enterprise;**

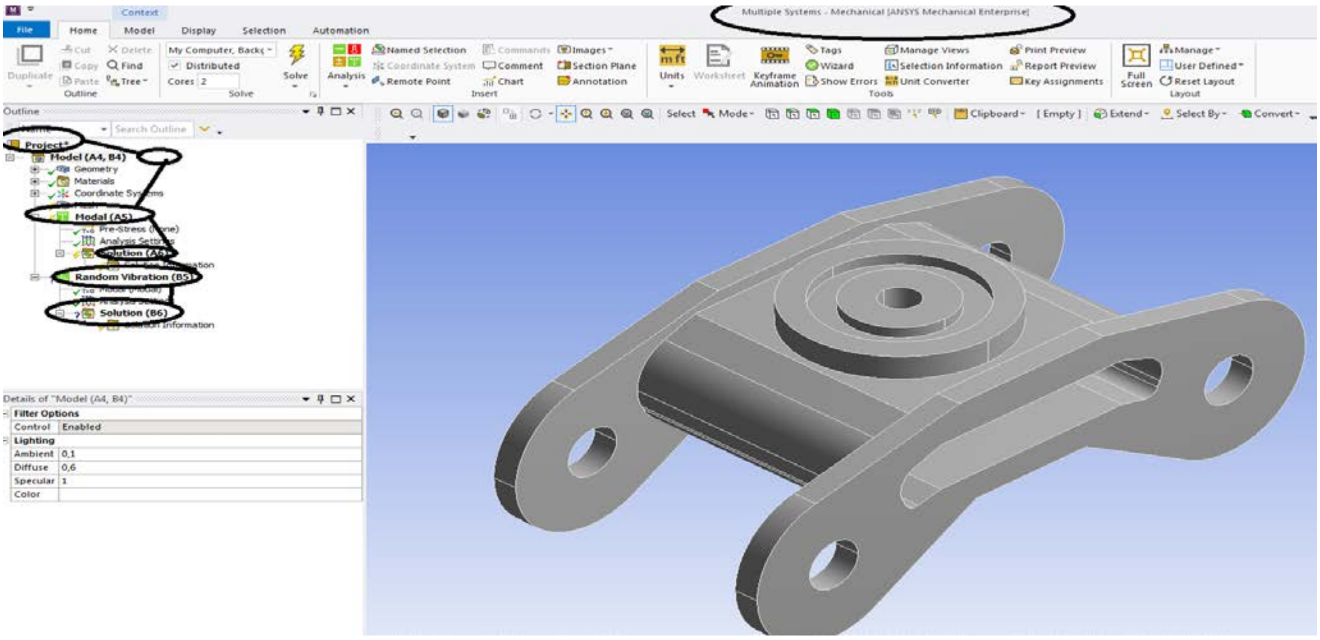


Figura 132 – Project – Model (A4,B4)-Modal (A5)- Solution (A6)-Random Vibration (B5)- Solution (B6)

- **se face discretizarea fina cu clic pe Mesch, apare casuta de dialog din stanga jos cu Details Mecch;**

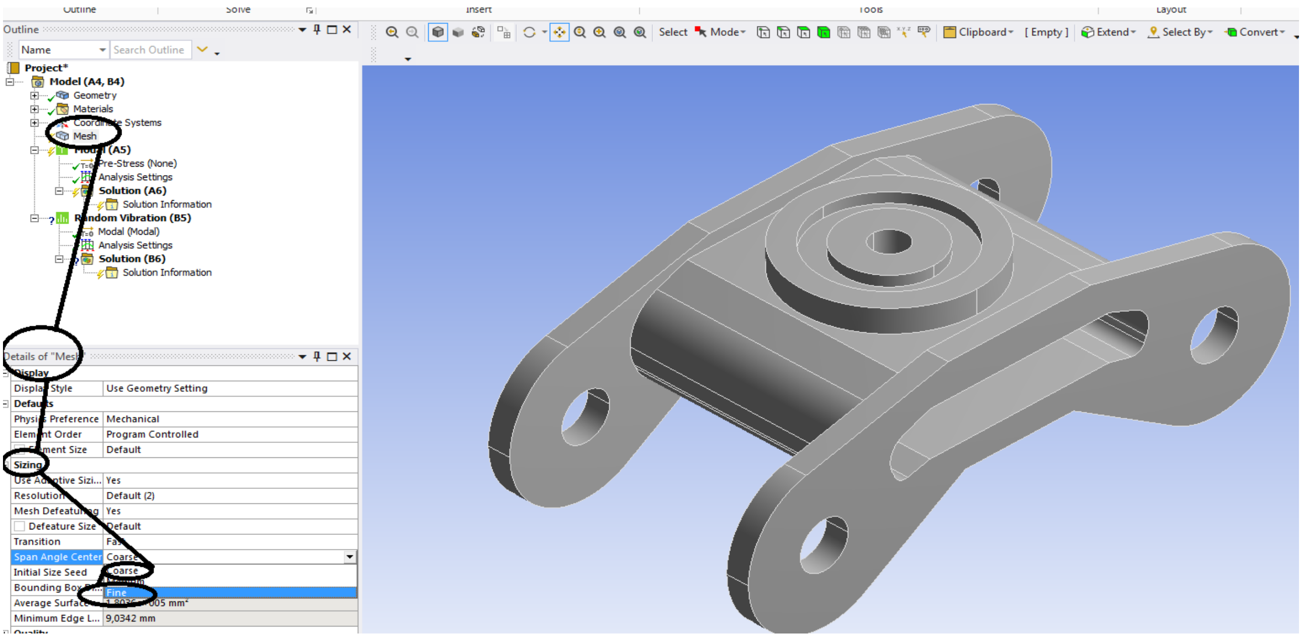


Figura 133 – Project – Model (A4,B4)- Mesch – Detail of „Mesch”

- **se clic pe Fine de la Details of Mesch;**
- **se duce la Mesch sus ;**
- **se da clic pe Mesch si apare –Update Mesch unde se da clic;**

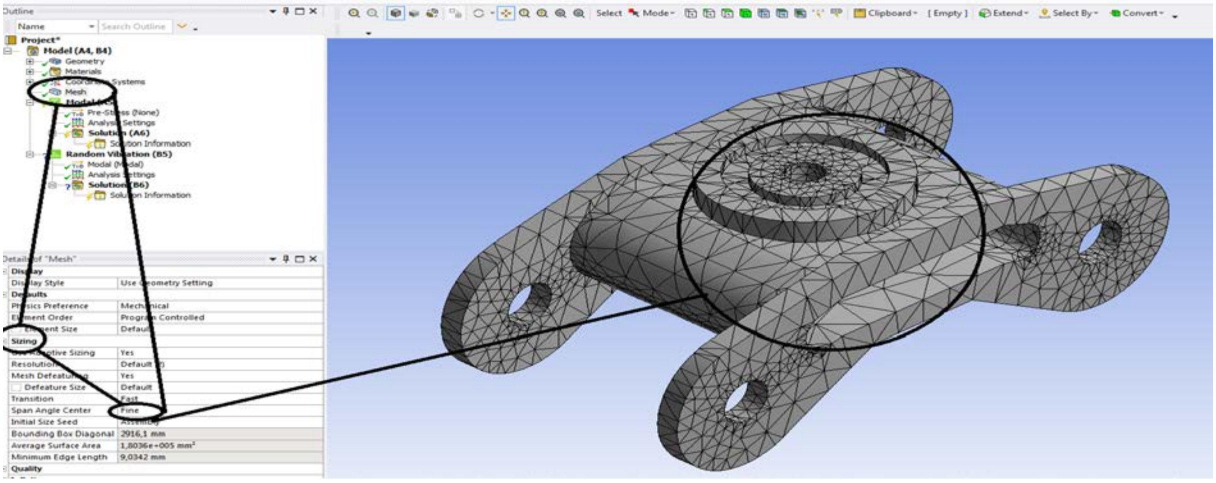


Figura 134 – Project – Model (A4,B4)- Mesch – Detail of „Mesch”- Discretizare fina

- **se duce la Modal A5-Insert-Fixed Support;**
- **se selecteaza suprafetele de reazem , in acest caz sunt patru suprafete,**
- **se selecteaza cu CTRL apasat;**

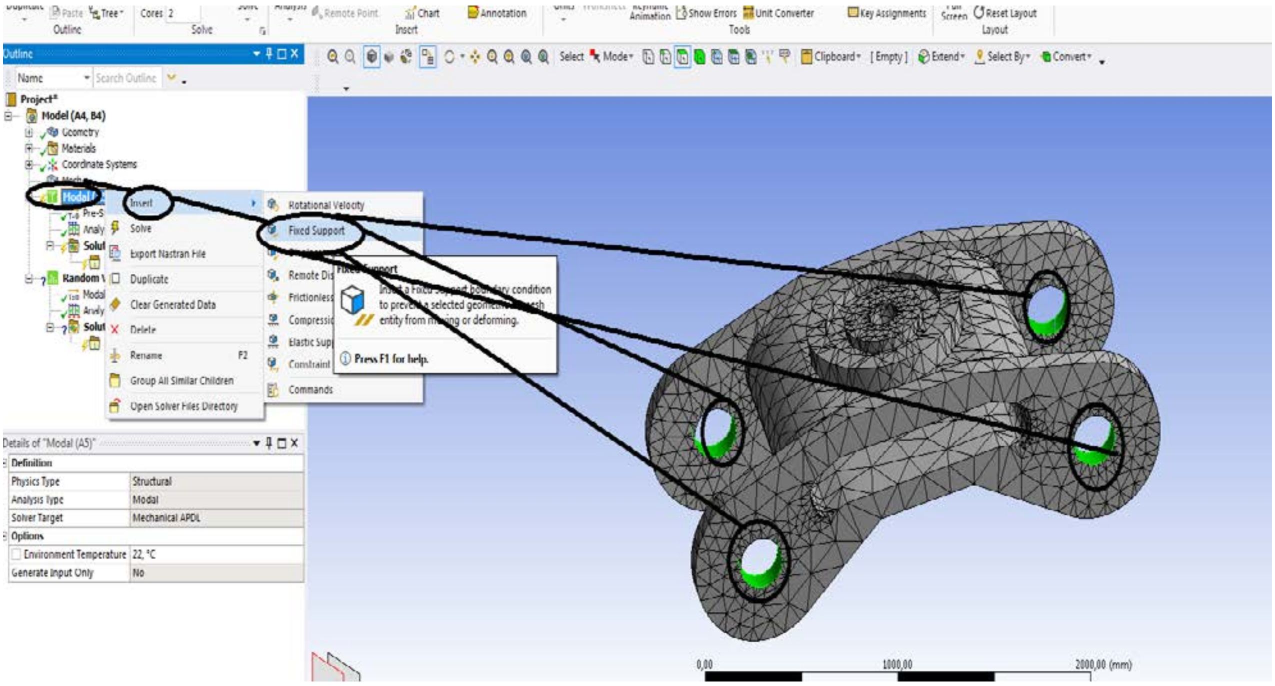


Figura 135 – Project – Modal (B5)-Insert- Fixed Support- Selectam suprafetele de reazem inainte

- **pentru solutii se procedeaza la fel;**
- **exemplu: Solution-Insert-Strain-Echivalent von Mises;**

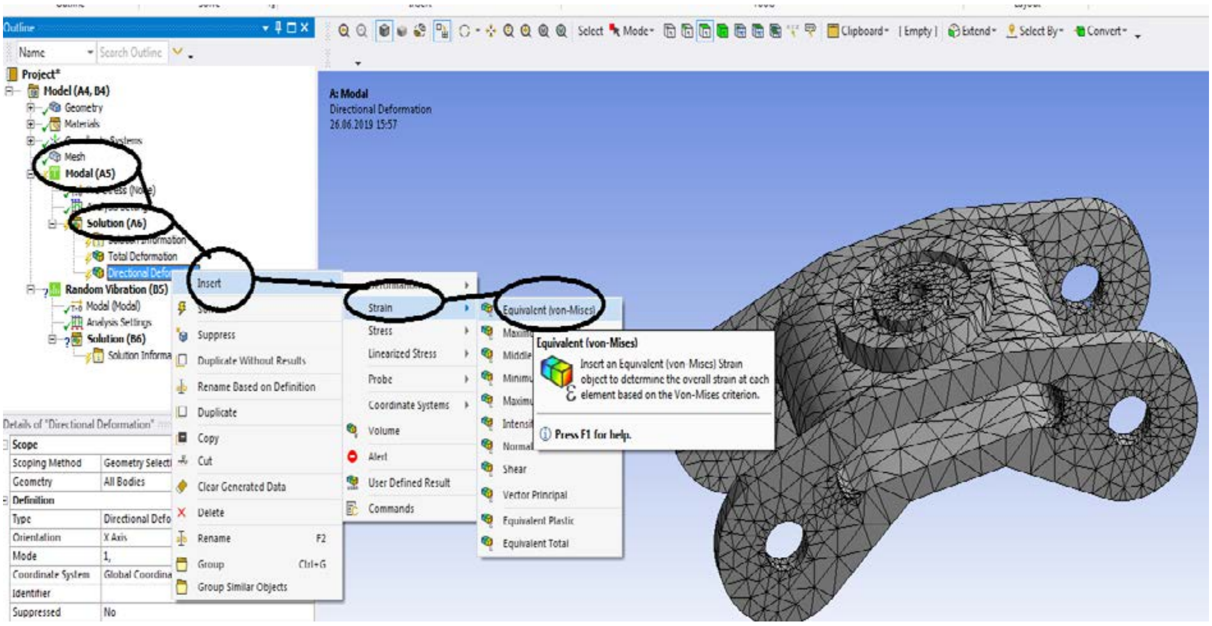


Figura 136 – Solution (A6) -Rezultate

-Se trece la Random Vibration;

- Random Vibration-Insert-PSD G Acceleration (acceleratia de excitatie);

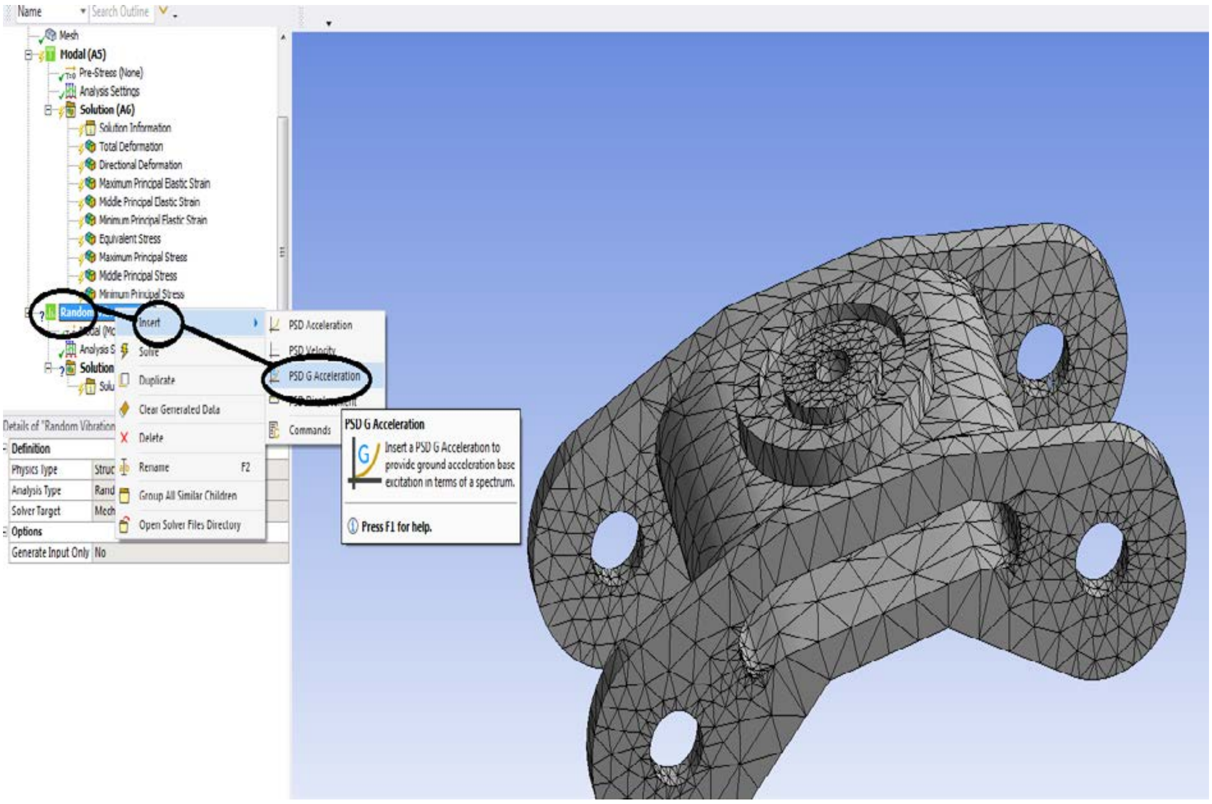


Figura 137 – Random Vibration

-Se da clic dreapta pe PSD G Acceleration (acceleratia de excitatie);

-se merge la Analysis Settings-Insert- PSD G Acceleration;

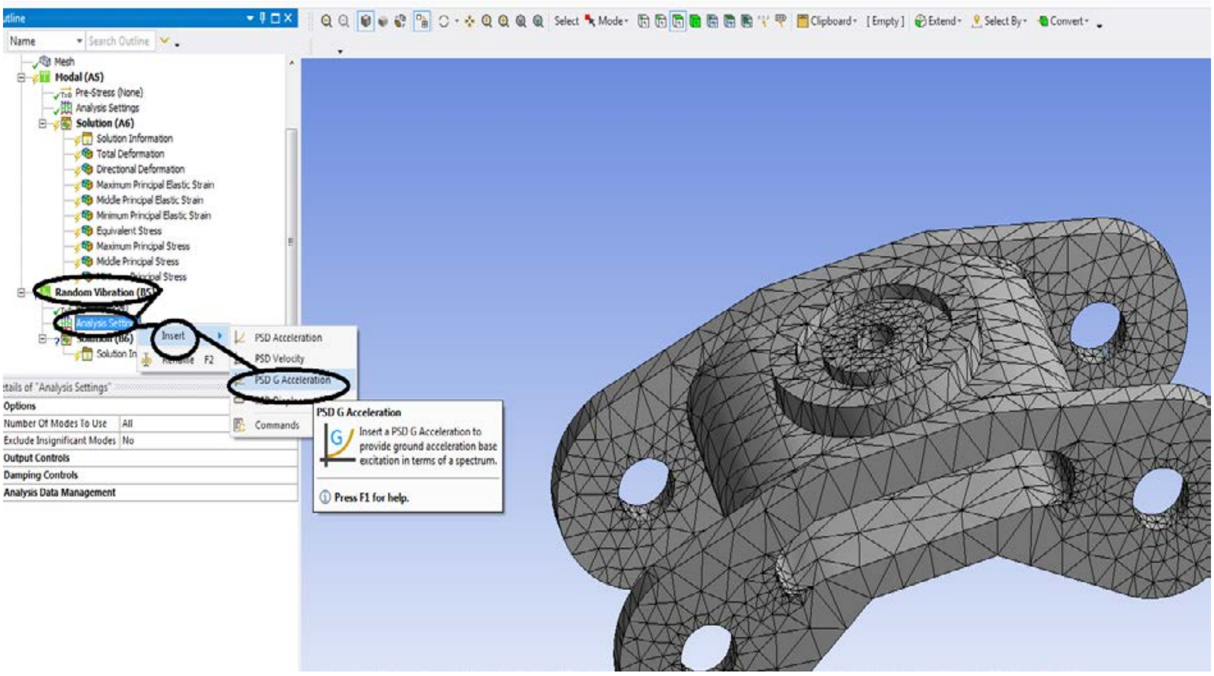


Figura 138 – Random Vibration- se incarca cu o acceleratie

-Se da clic dreapta pe PSD G Acceleration (acceleratia de excitatie);

- apare casuta de dialog , partea stanga jos

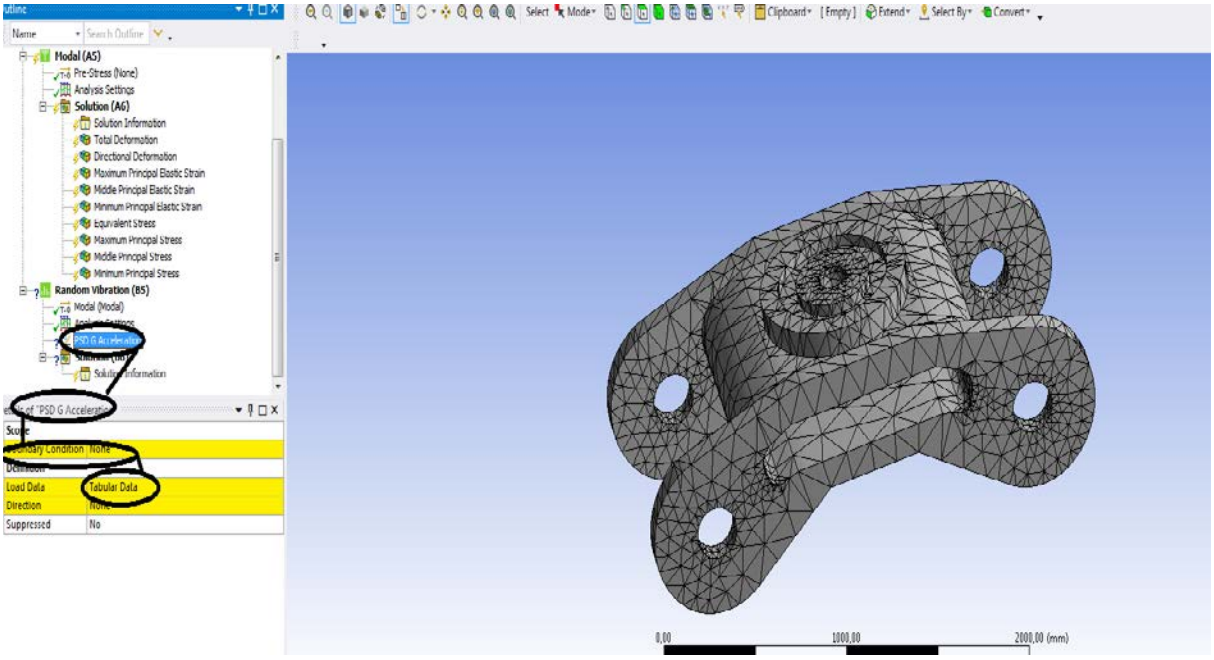


Figura 139– Random Vibration- se incarca cu o acceleratie (Tubular Data)

- **In Modal A5 se face –Fixed Support (REAZEM INCASTRAT)**
- **Din Details of RSD G Acceleration- Boundary Condition- Fixed Support**

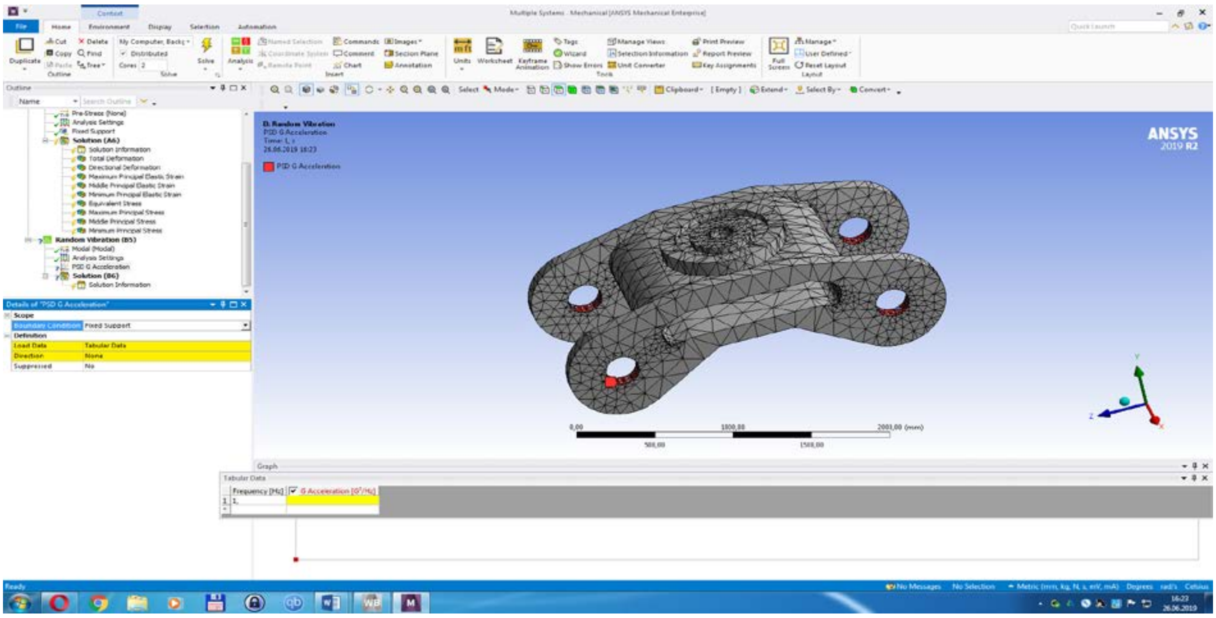


Figura 140– Random Vibration- se incarca cu o acceleratie (Tubular Data)- se pun valorile jos in dreapta

- **Din Details of RSD G Acceleration- Boundary Condition- Fixed Support;**
- **Se da clic dreapta pe Fixed Support si se obtine;**

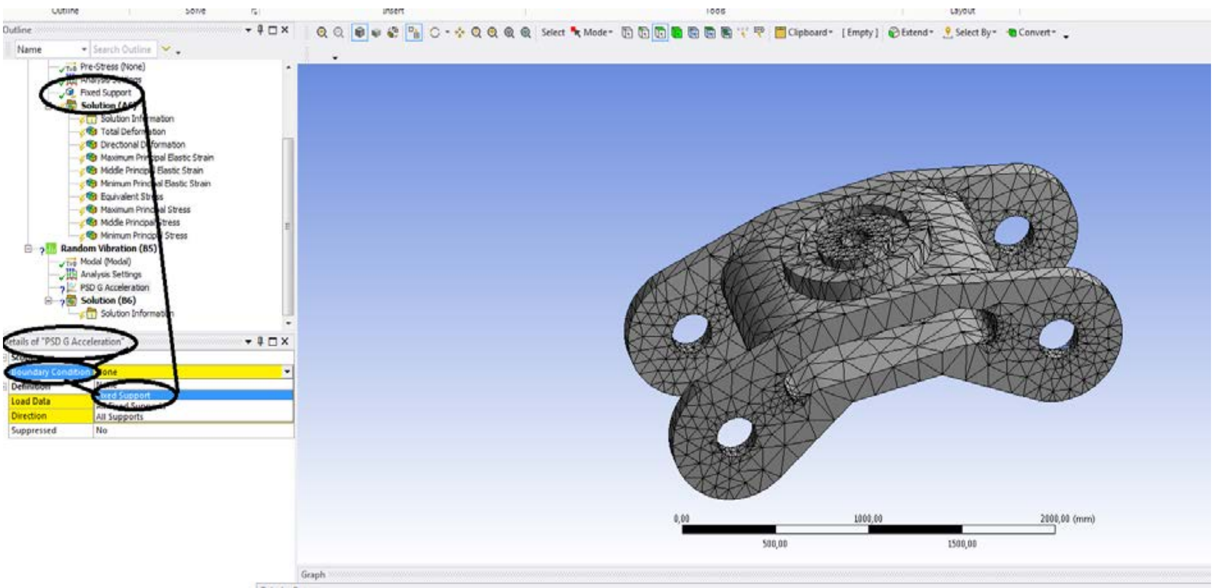


Figura 141– Random Vibration- Details of „ PSD G Acceleration"

- **Din Details of RSD G Acceleration- Direction- Z axis;**

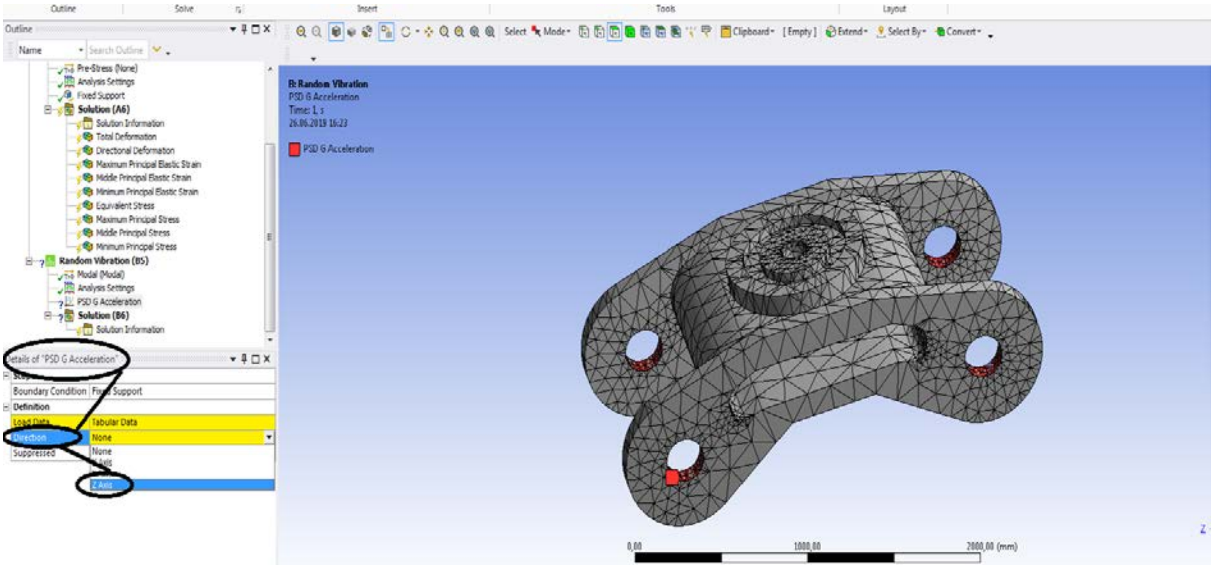


Figura 142– Random Vibration- Details of „ PSD G Acceleration”-Directia acceleratiei de excitatie

-Tubular Data;

- se pune frecventa si apoi acceleratia ;

- se urmareste si graficul din dreapta la Tubular Data

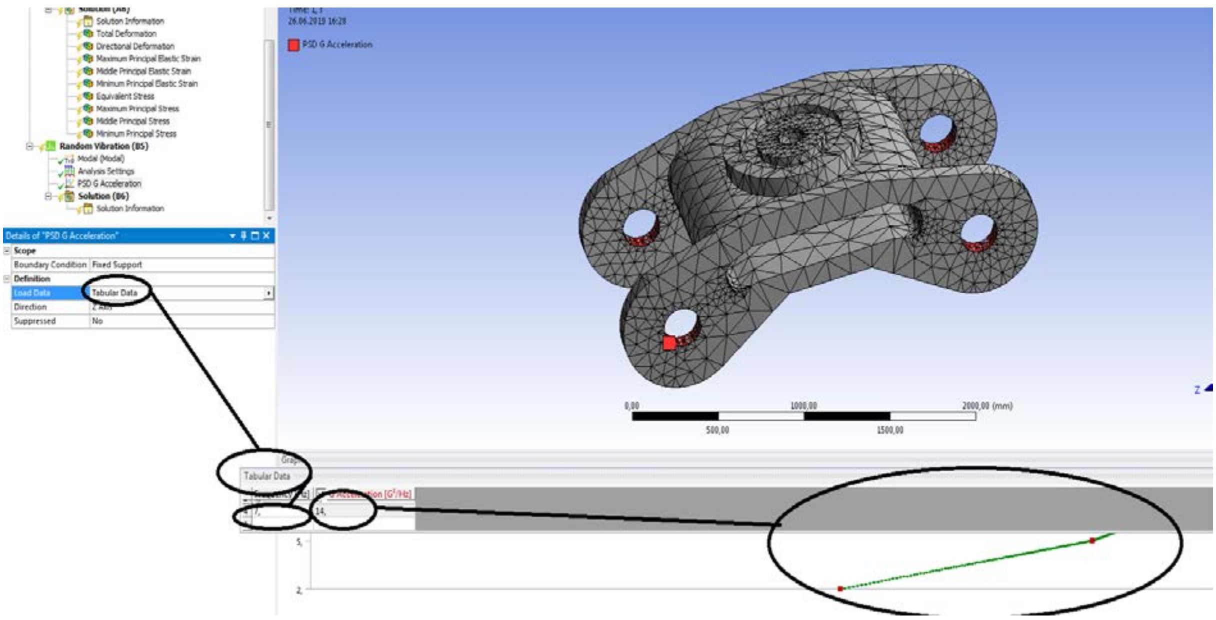


Figura 143– Random Vibration- Details of „ PSD G Acceleration”-Directia acceleratiei de excitatie si tubular data

-Solutin B6-Insert-Deformation- Directional sau Directional Velocity, Directional Acceleration

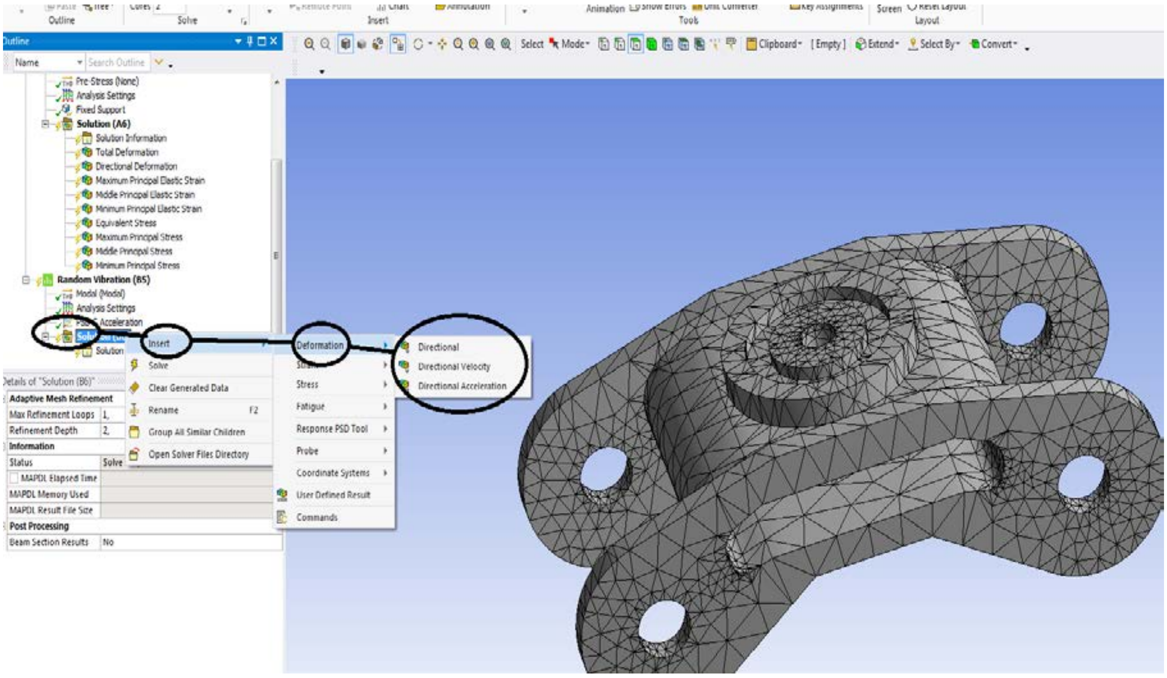


Figura 144 – Random Vibration-Solution

1.10 Rezultatele de la vibratii pentru boghiu

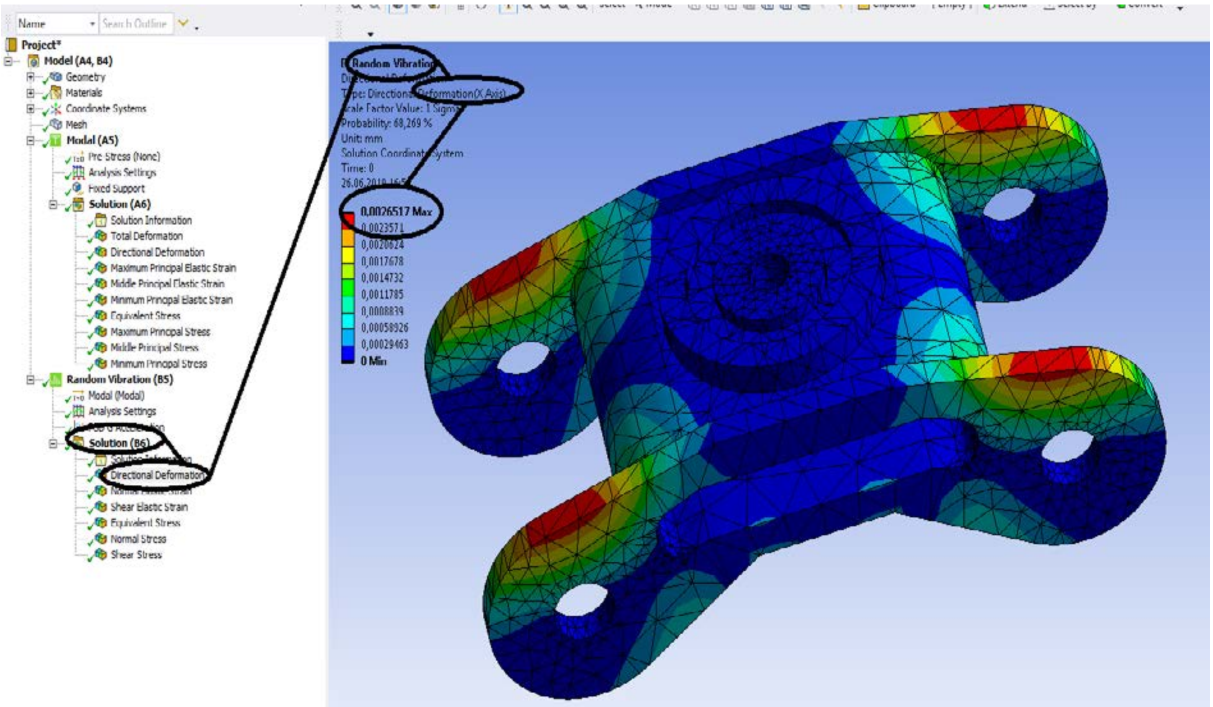


Figura 145 -Deformații direcționale pe axa x [mm]

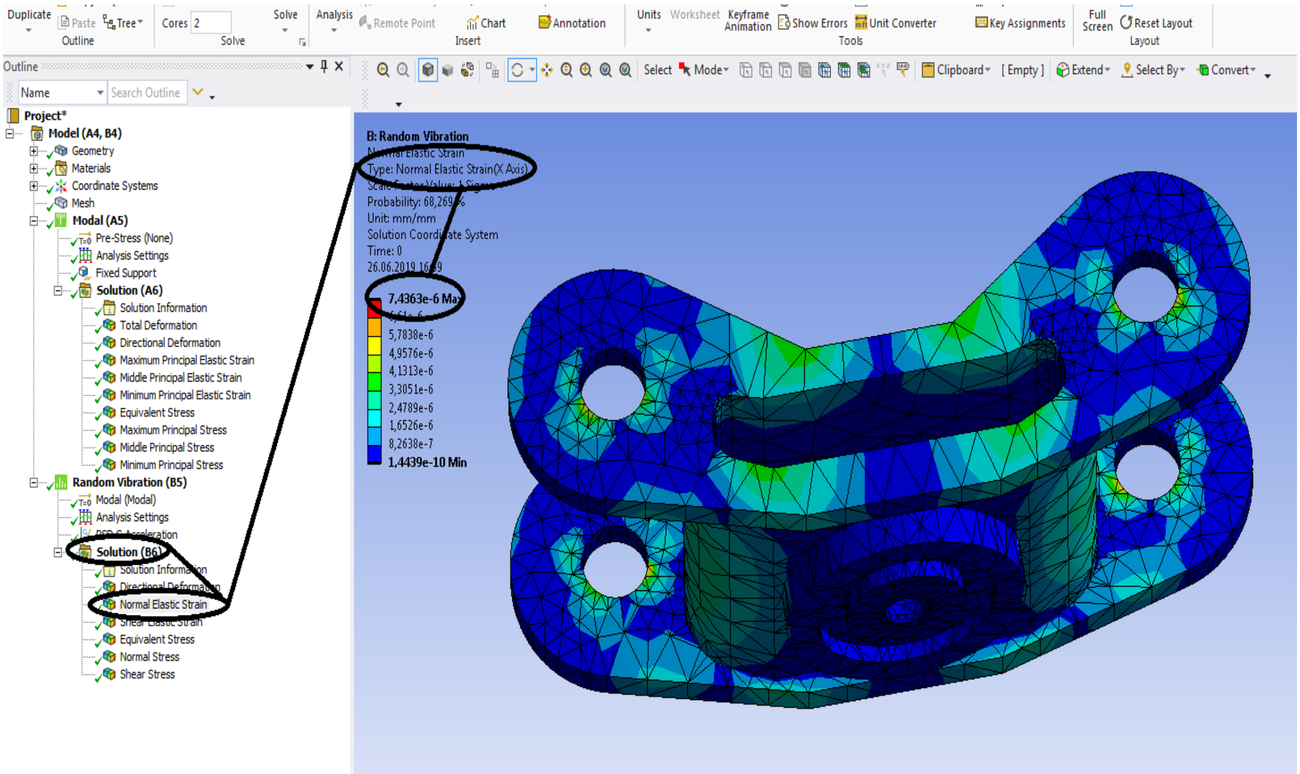


Figura 146 - Deformațiile normale specifice (dupa axa OX) [mm/mm]

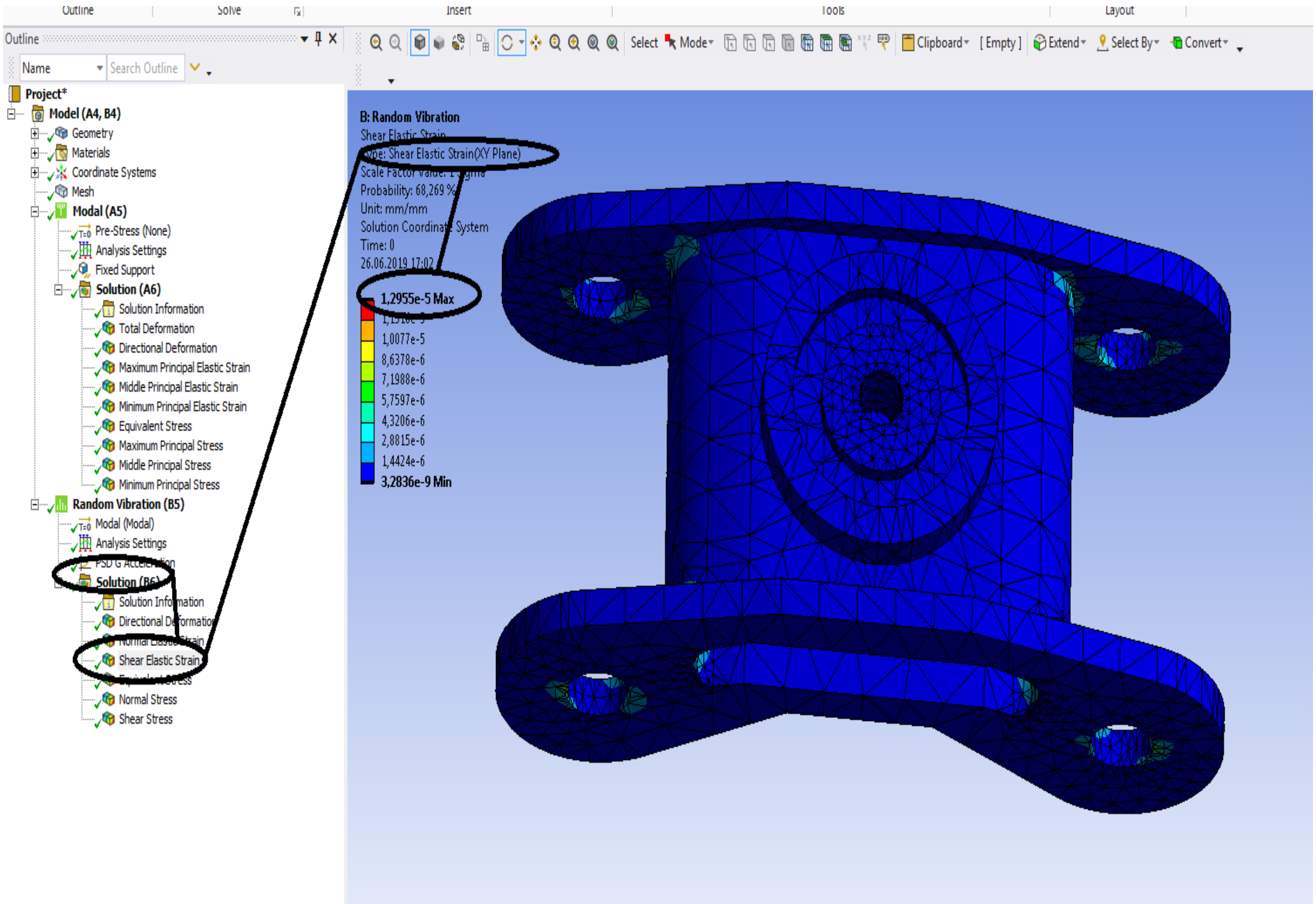


Figura 147 -Lunecarile specifice in planul XOY

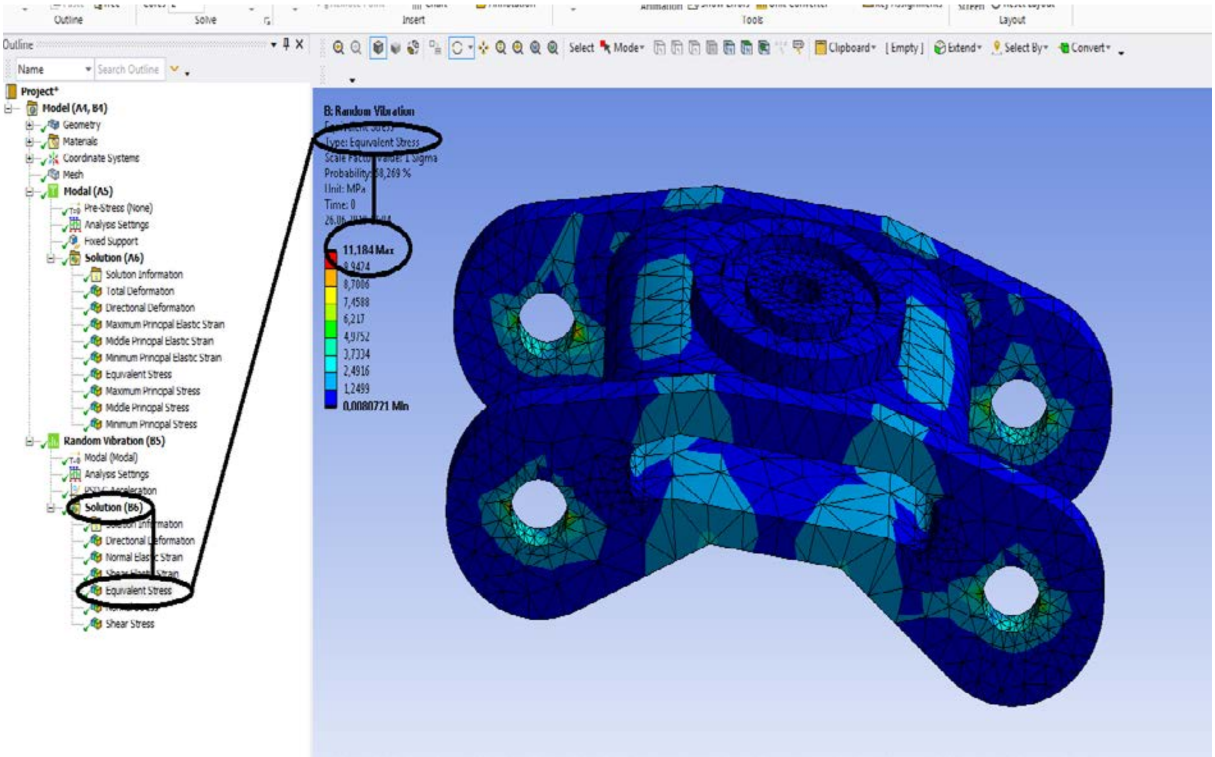


Figura 148 - Tensiunile echivalente [MPa]

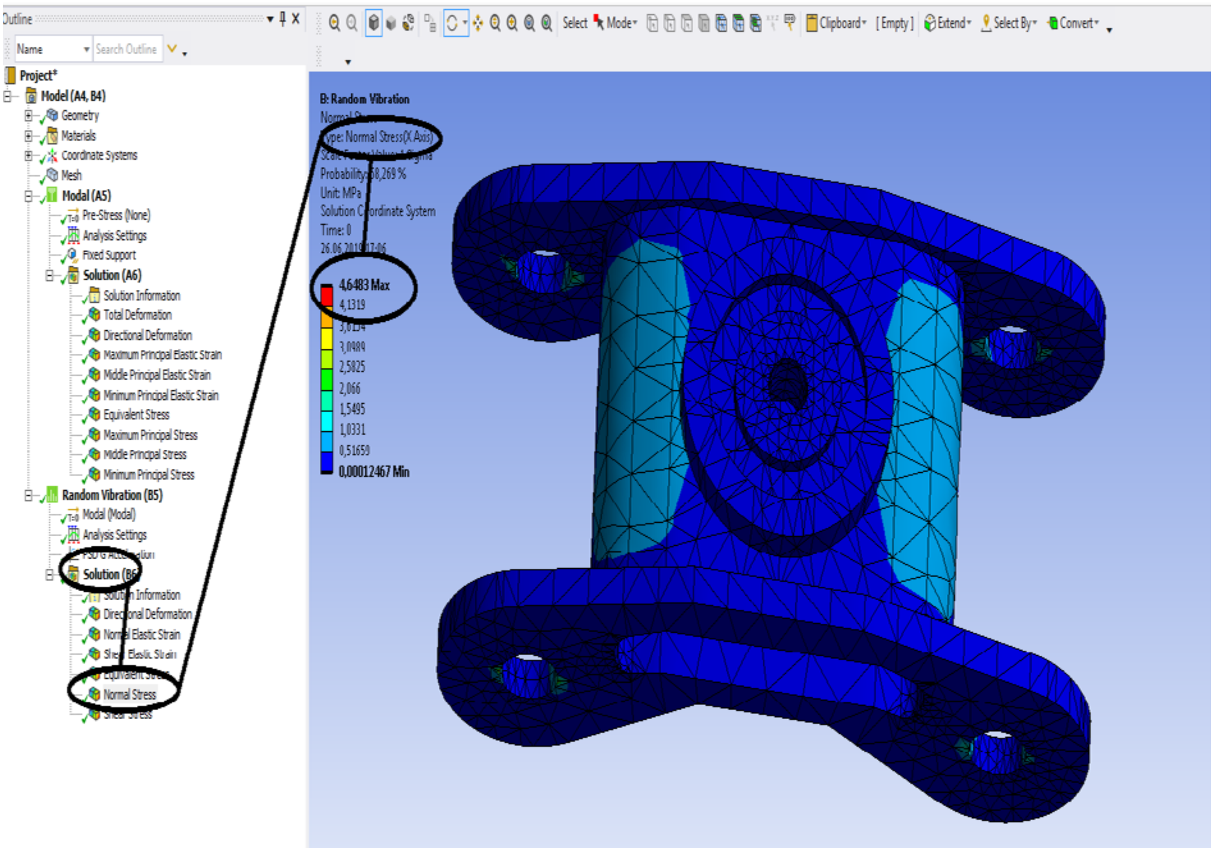


Figura 149 -Tensiuni normale dupa axa OX [MPa]

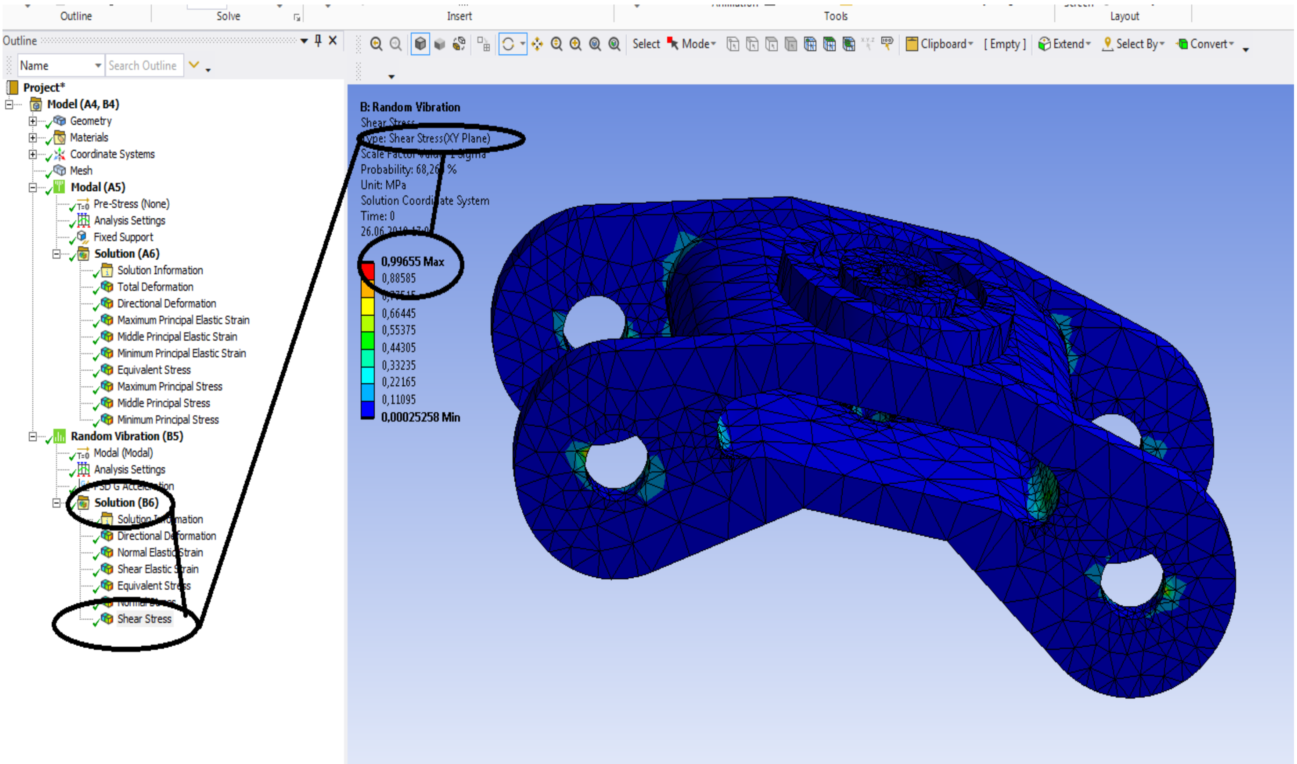


Figura 150 -Tensiuni tangentiale din planul XOY [MPa]

Capitol 2 -Sasiu vagon cale ferata

2.1 Static structural mecanic

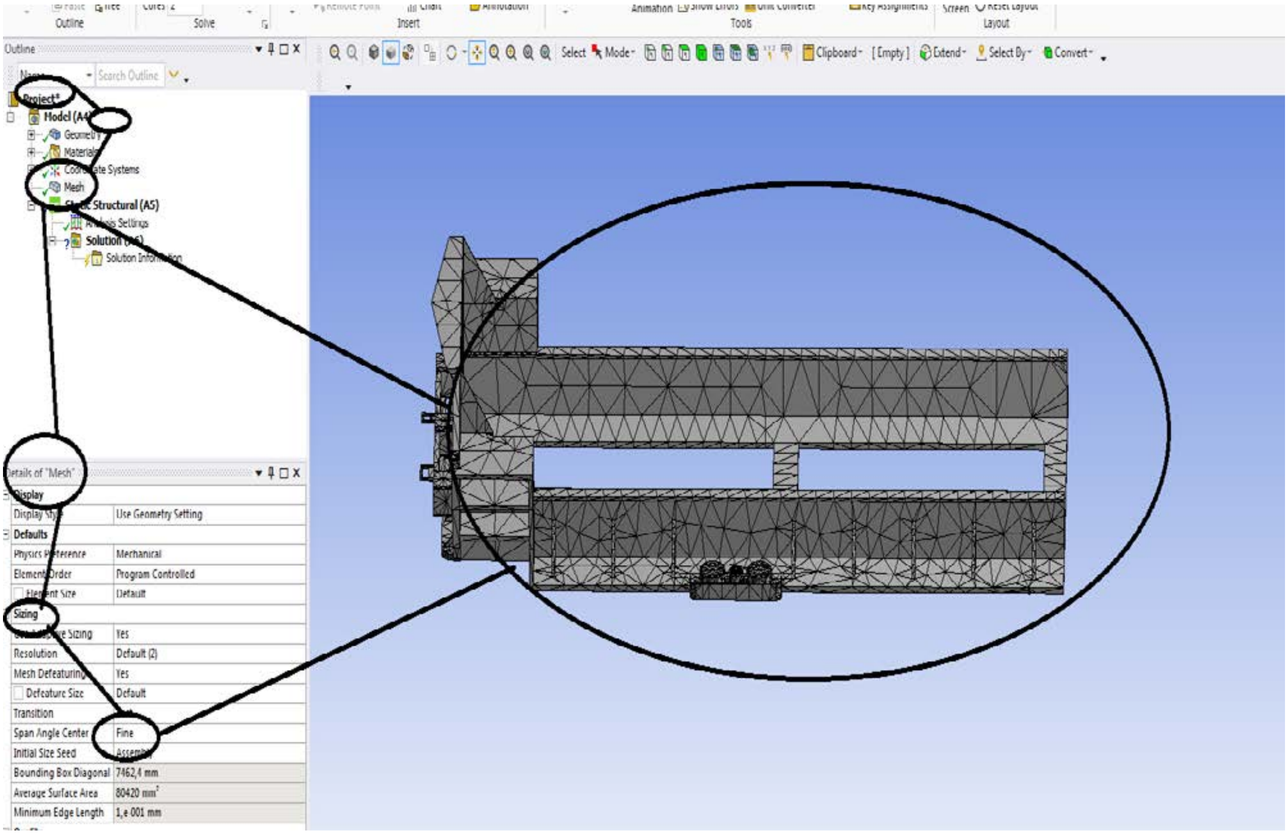


Figura 151- Sasiu discretizat

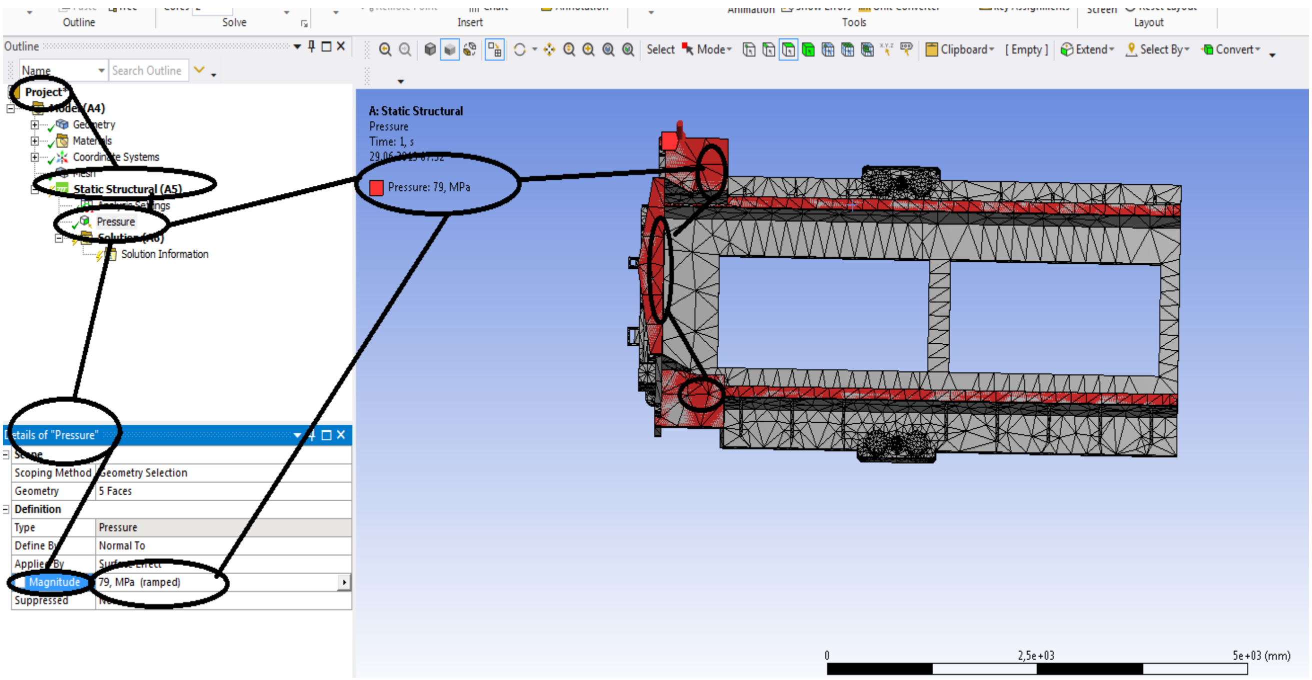


Figura 152- Incarcarea sasiului

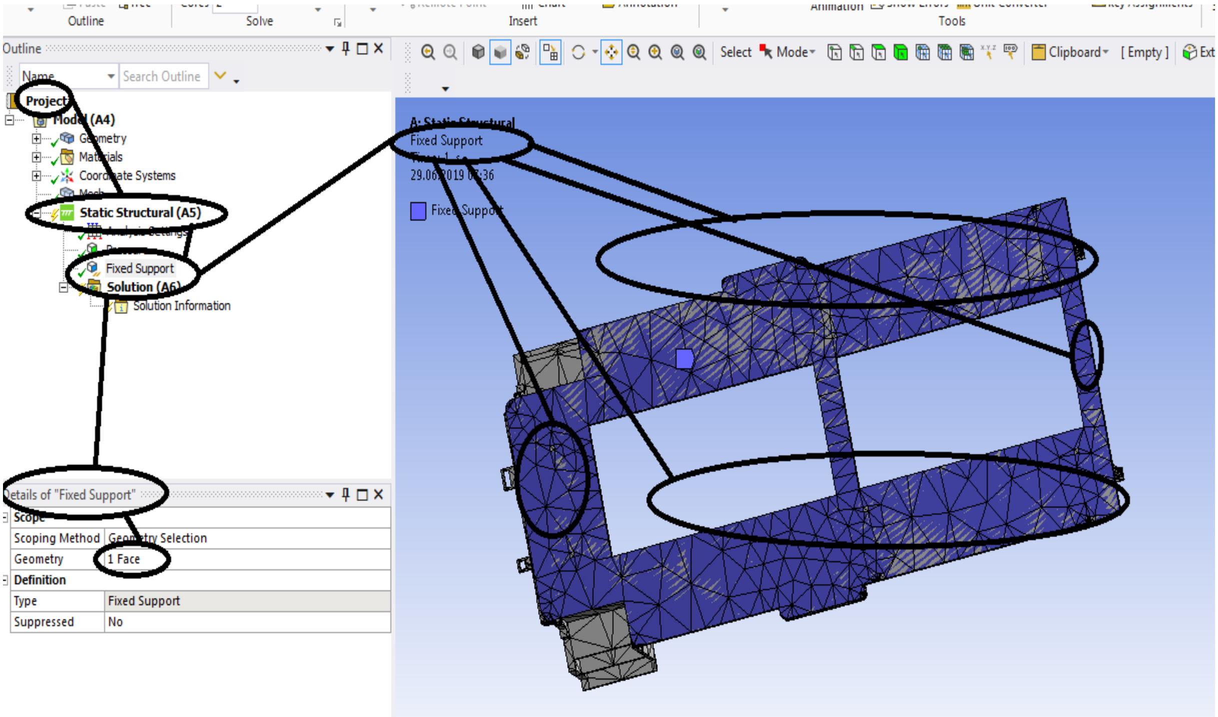


Figura 153- Rezemarea sasiului

2.2 Rezultatele de la static structural mecanic pentru sasiu

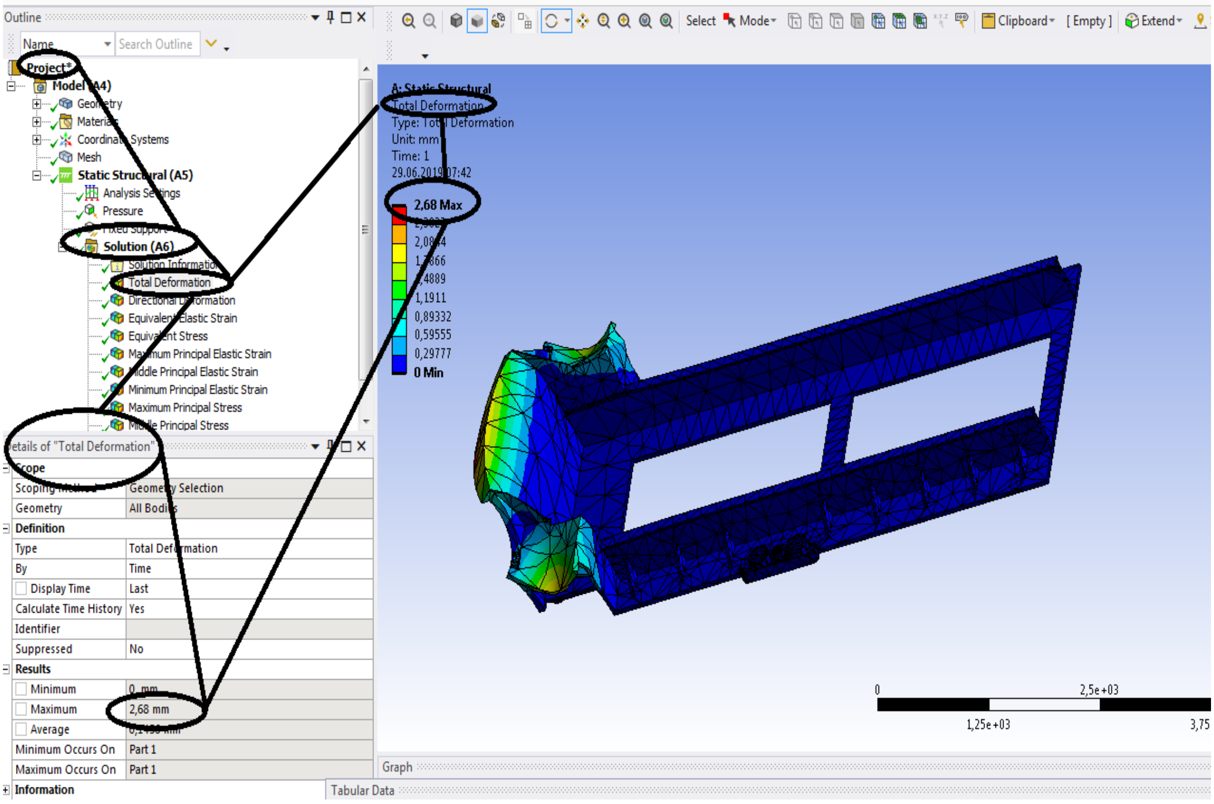


Figura 154 - Deformații totale [mm]

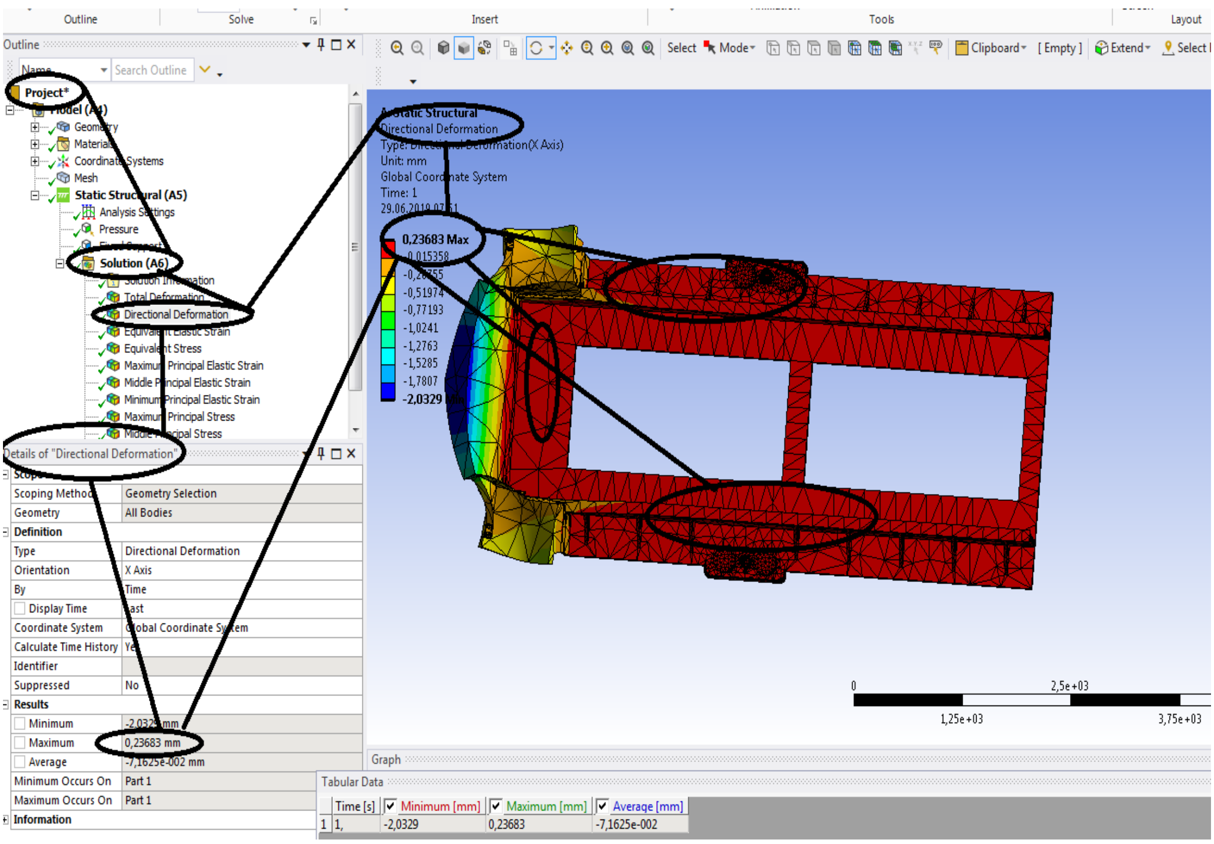


Figura 155 - Deformații direcționale pe axa x [mm]

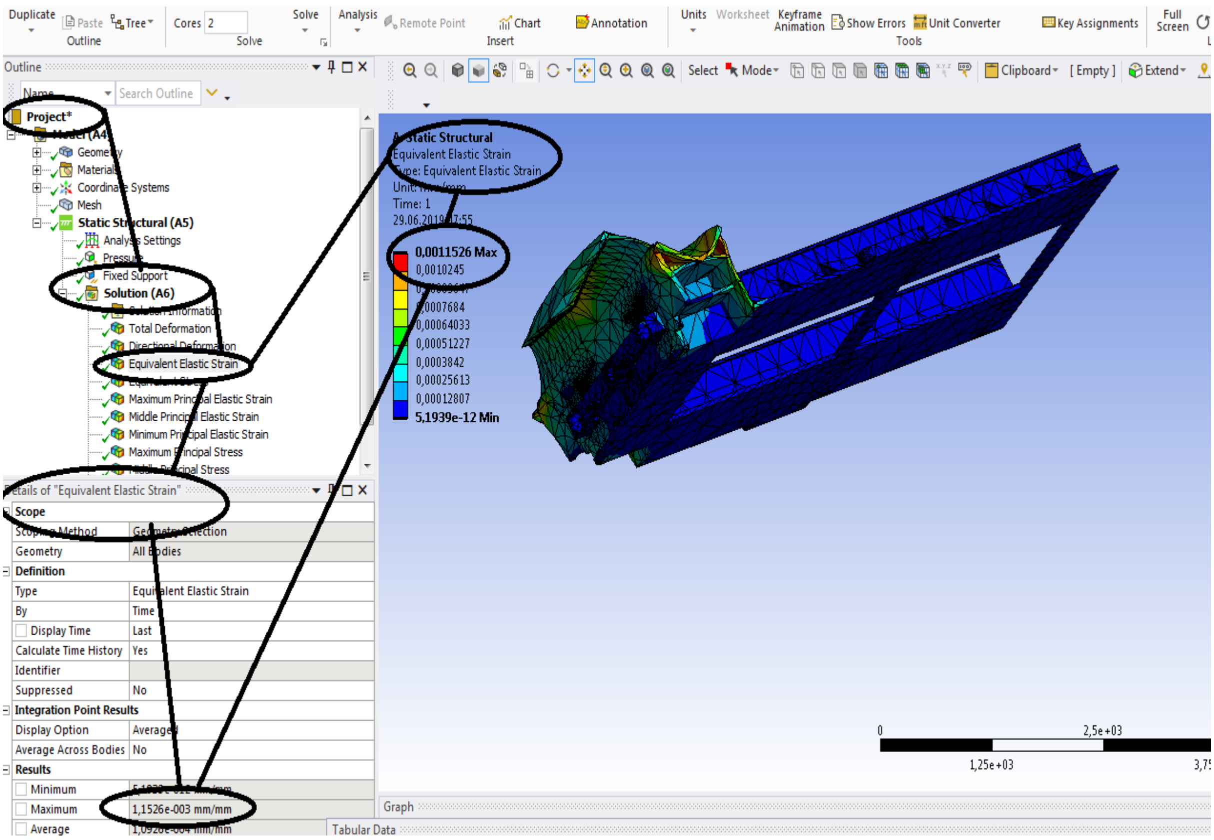


Figura 156- Deformațiile specifice echivalente ε [mm/mm]

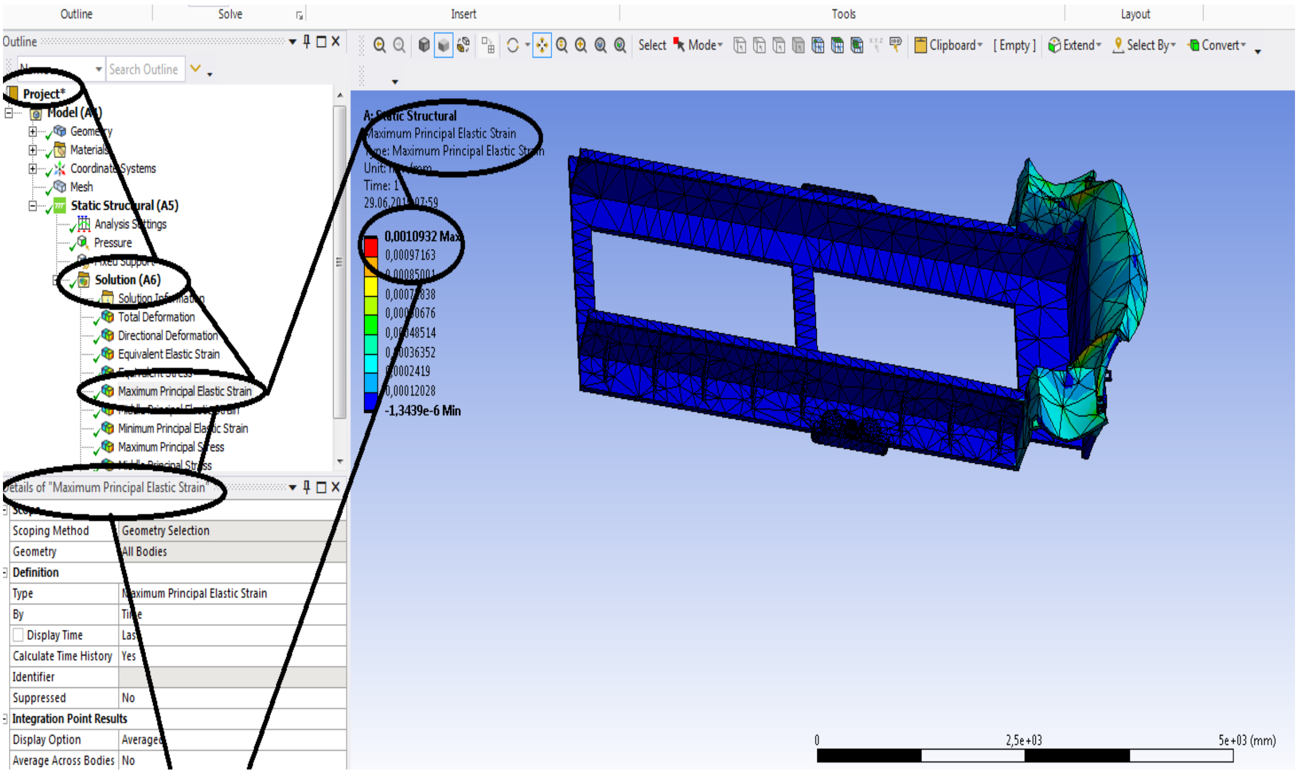


Figura 157 - Deformațiile specifice principale - ε1 [mm/mm]

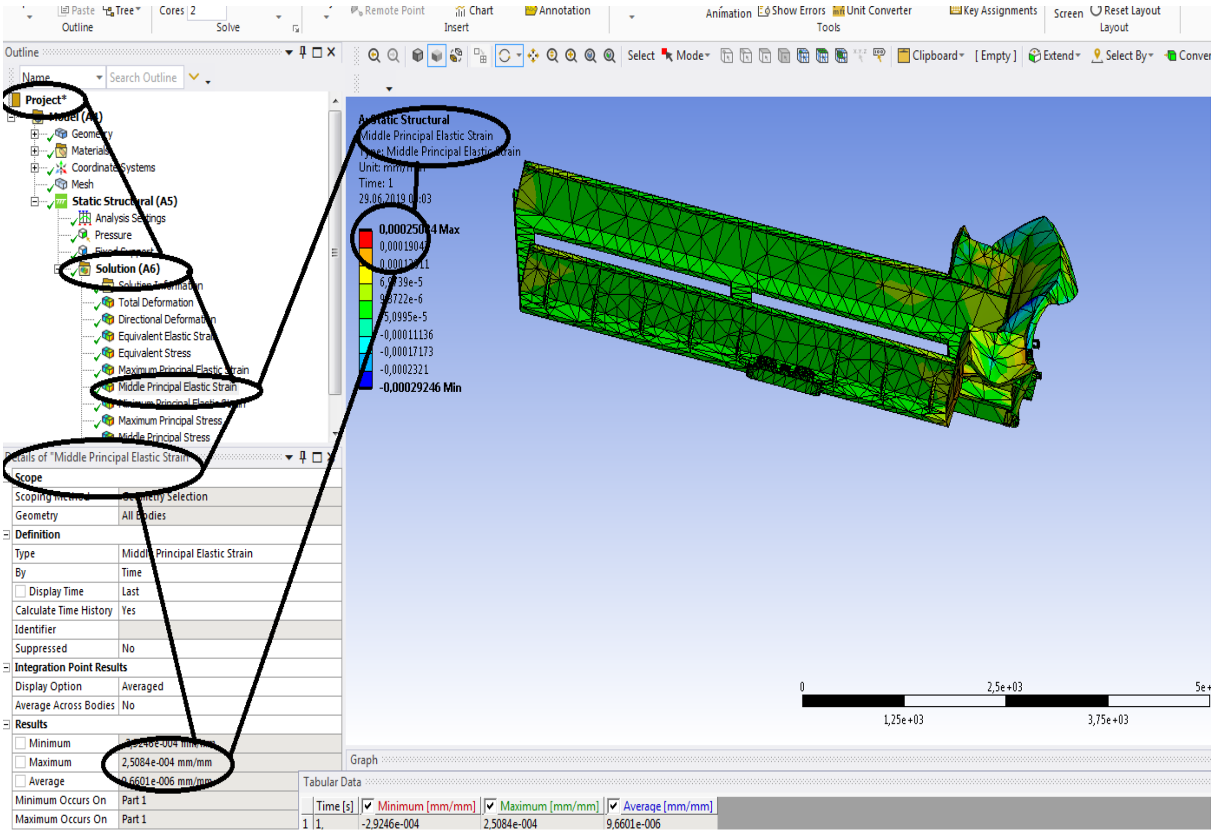


Figura 158 - Deformațiile specifice principale ε2 [mm/mm]

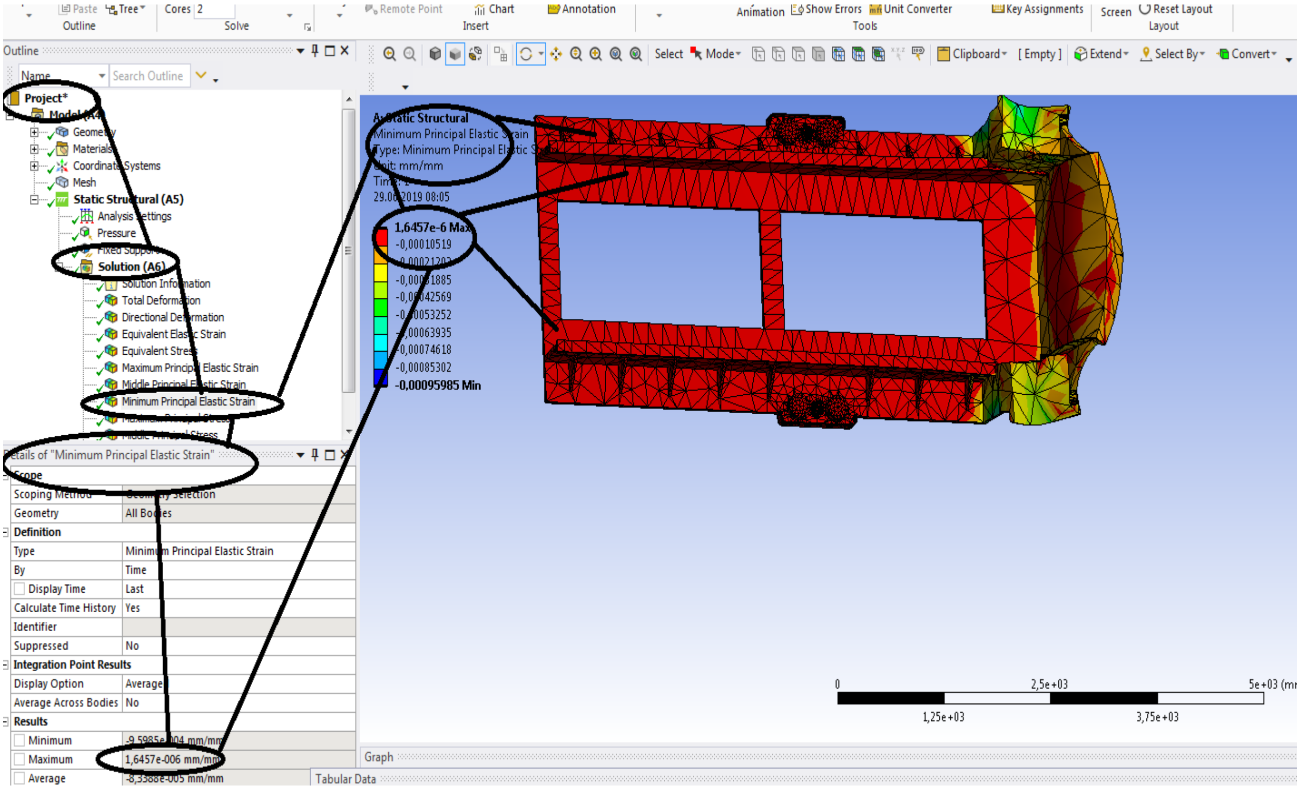


Figura 159 - Deformațiile specifice principale ε3 [mm/mm]

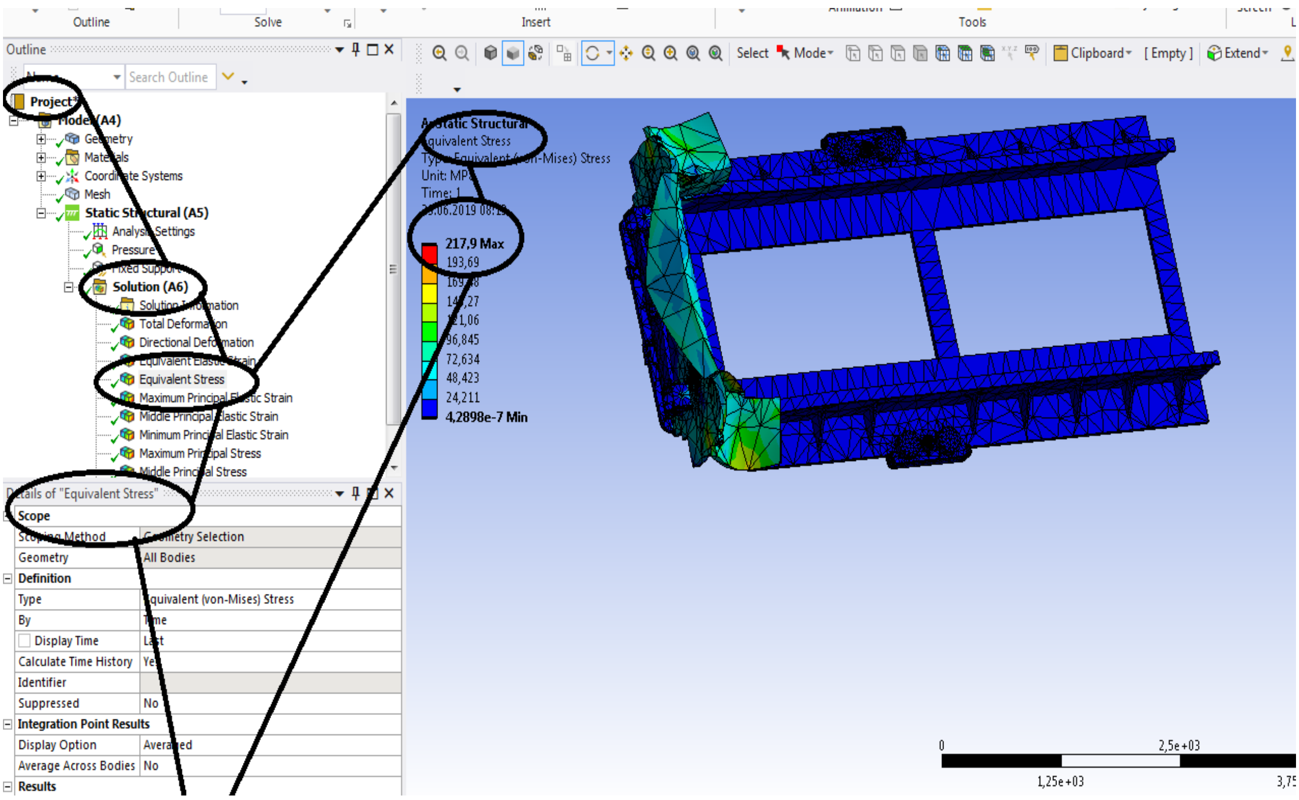


Figura 160 - Tensiunile echivalente von Mises [MPa]

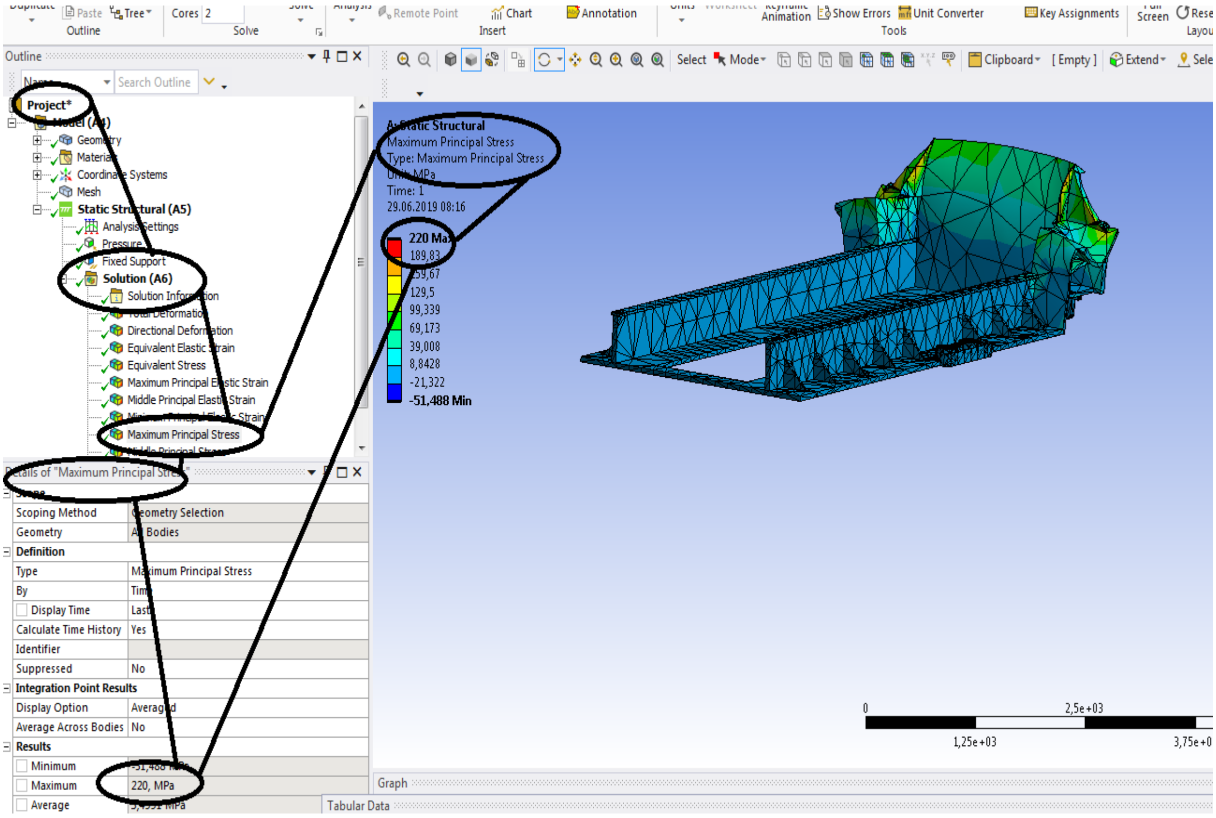


Figura 161 - Tensiunile principale $\sigma 1$ [MPa]

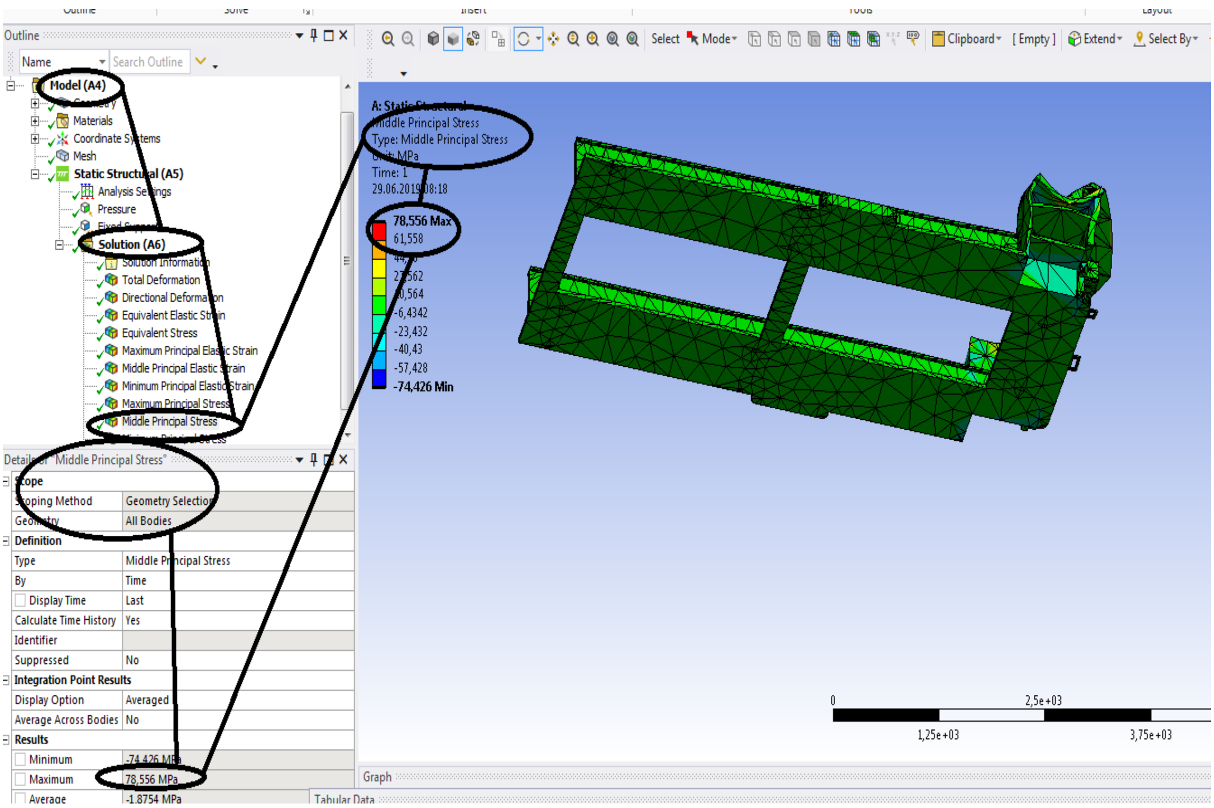


Figura 162 - Tensiunile principale $\sigma 2$ [MPa]

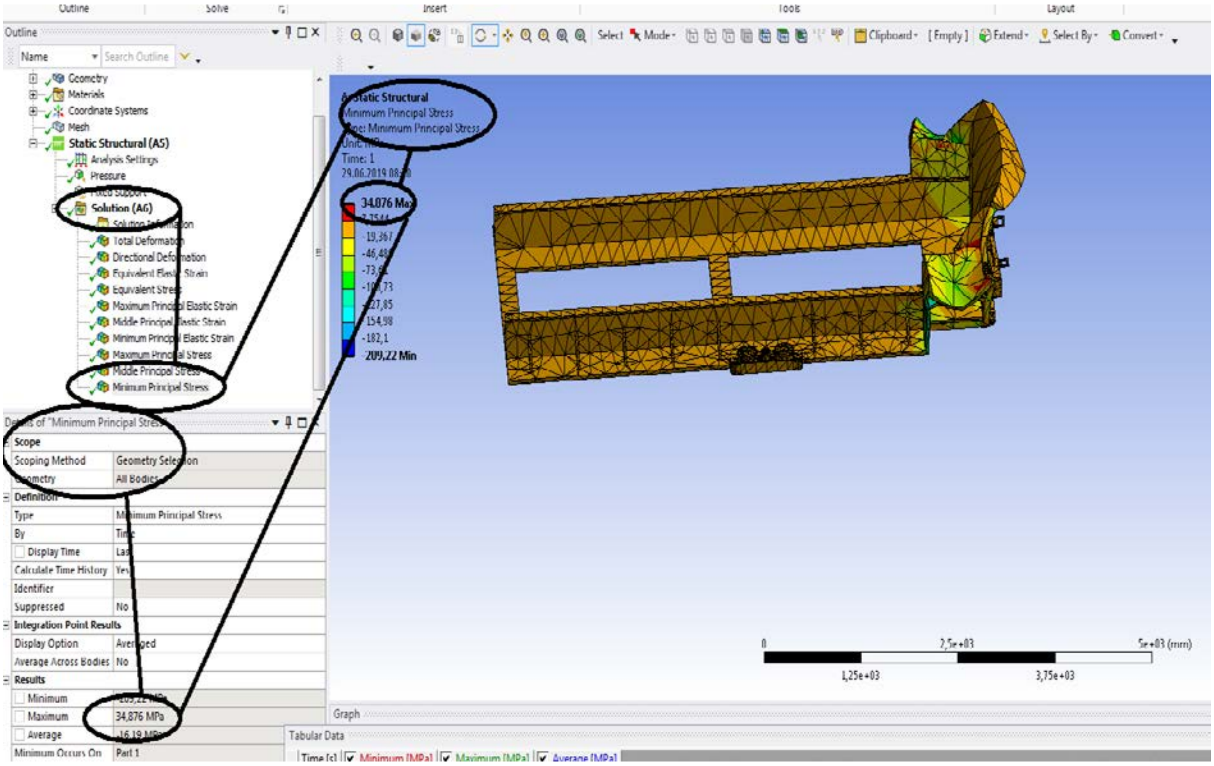


Figura 163 -Tensiunile principale $\sigma 3$ [MPa]

2.3 Static structural termic pentru sasiu

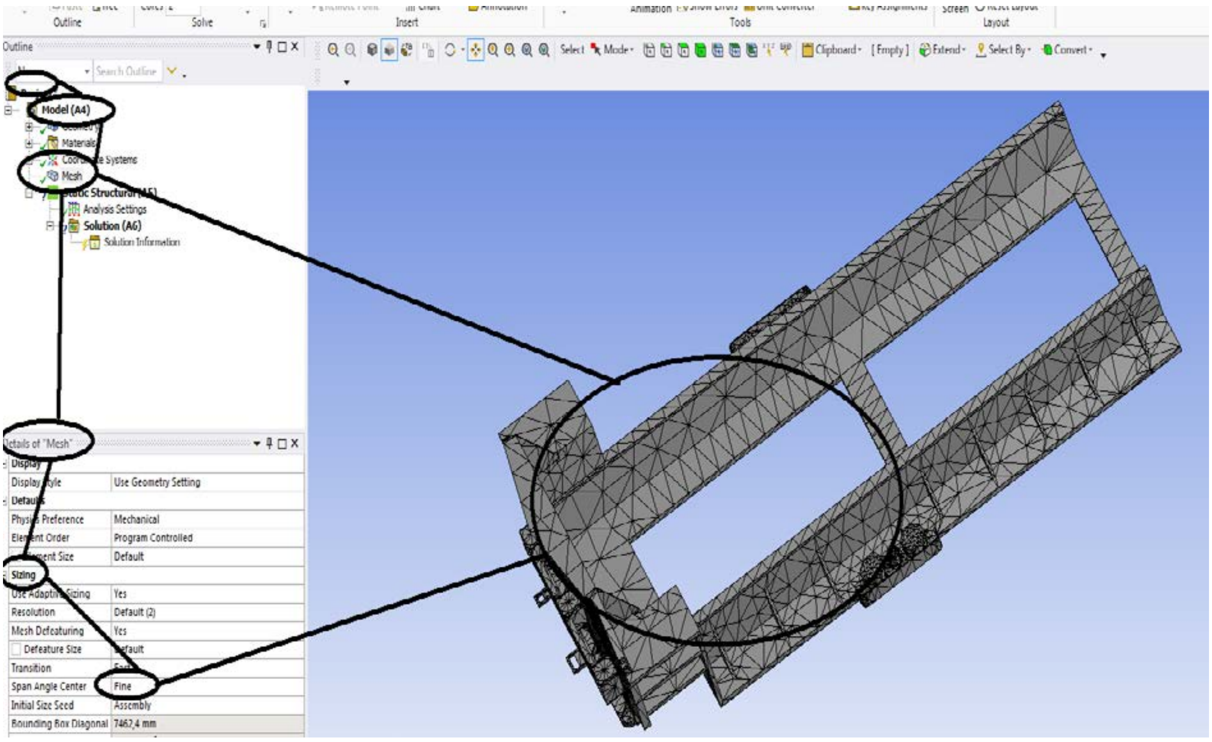


Figura 164 –Sasiu - Discretizarea fina

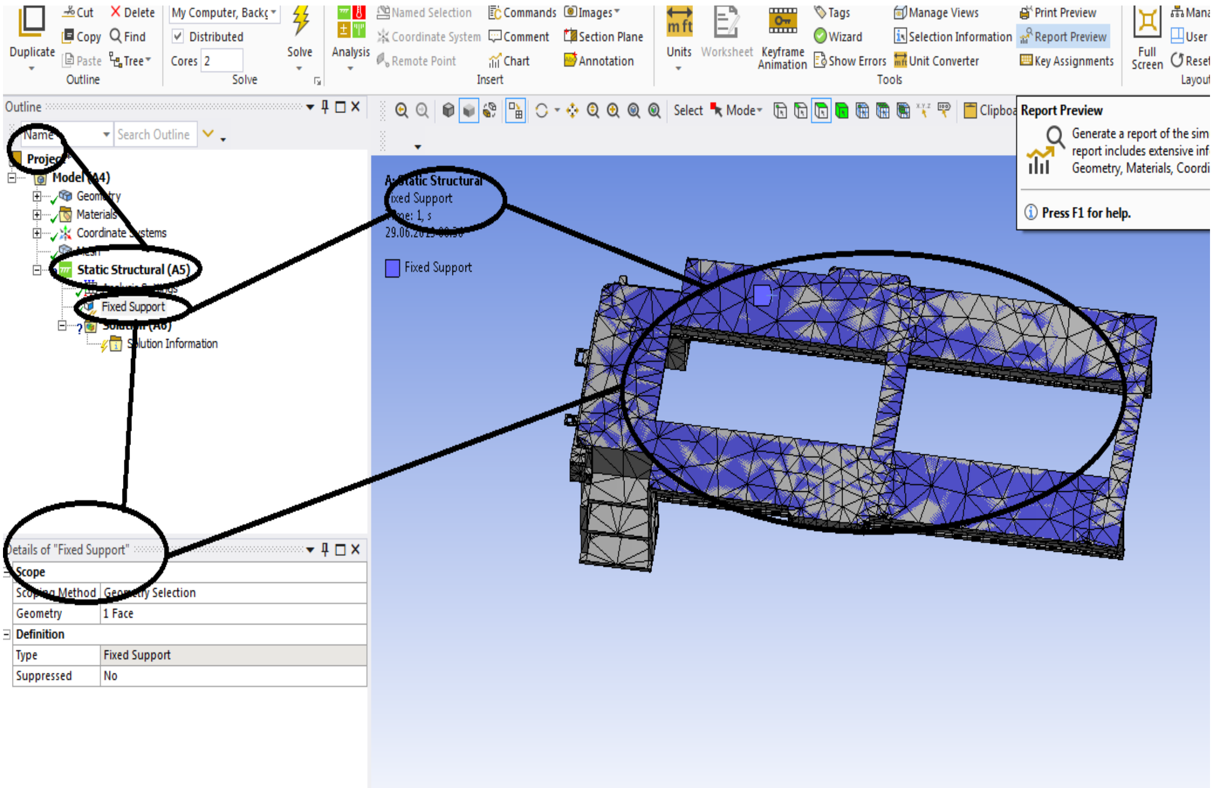


Figura 165 –Sasiu - Rezemarea sasiului

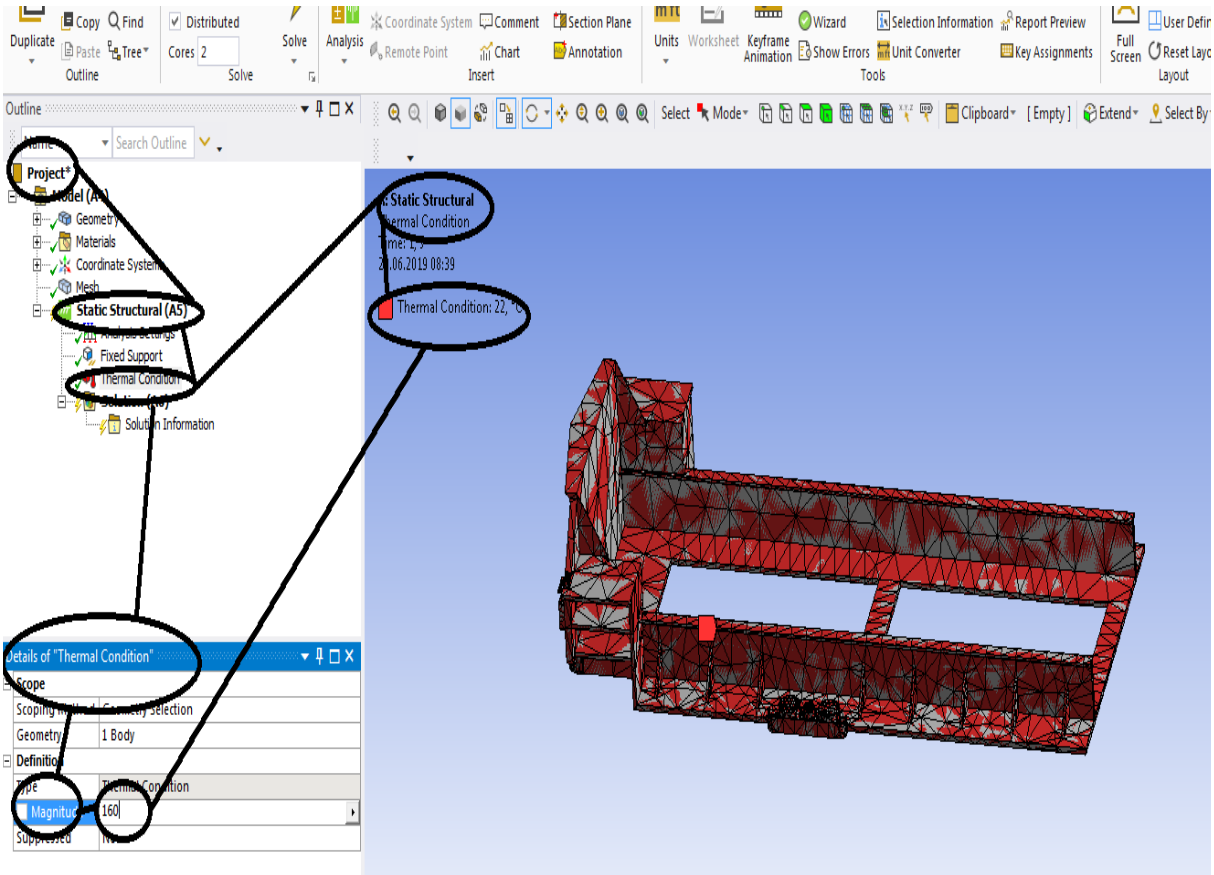


Figura 166 –Sasiu - Incarcarea termica

2.4 Static structural termic pentru sasiu- Rezultate

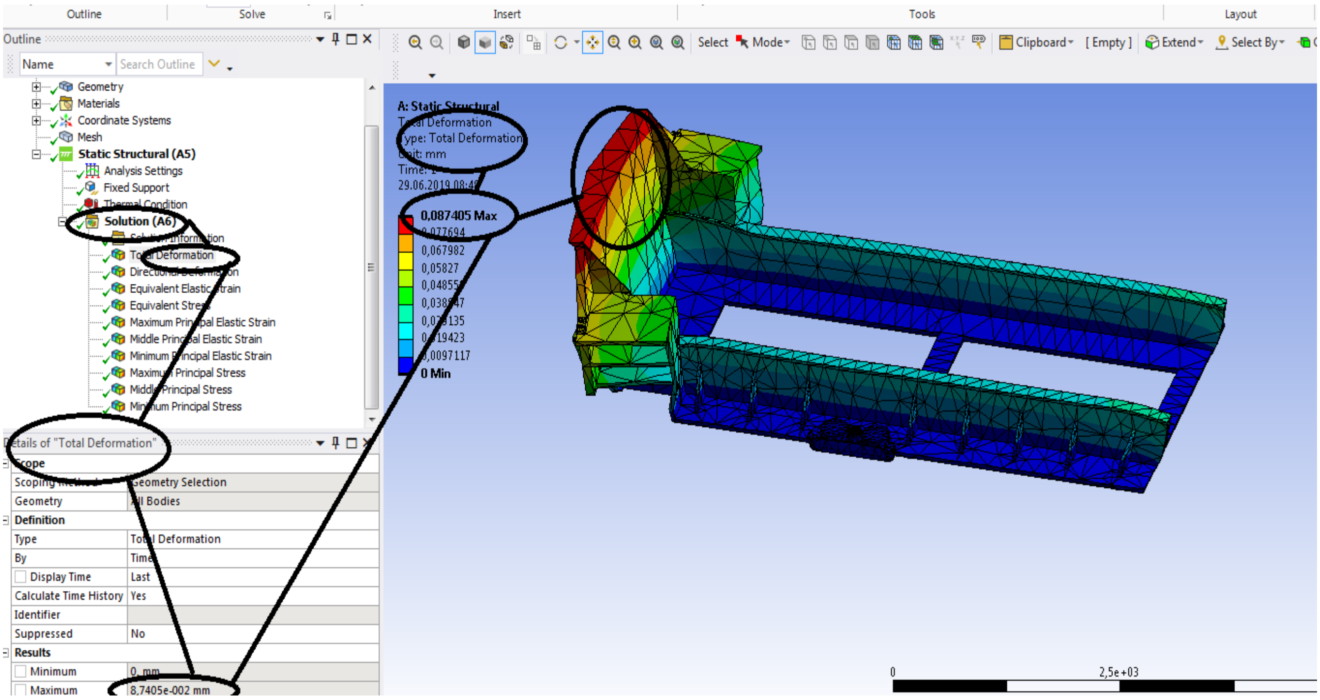


Figura 167 - Deformații totale [mm]

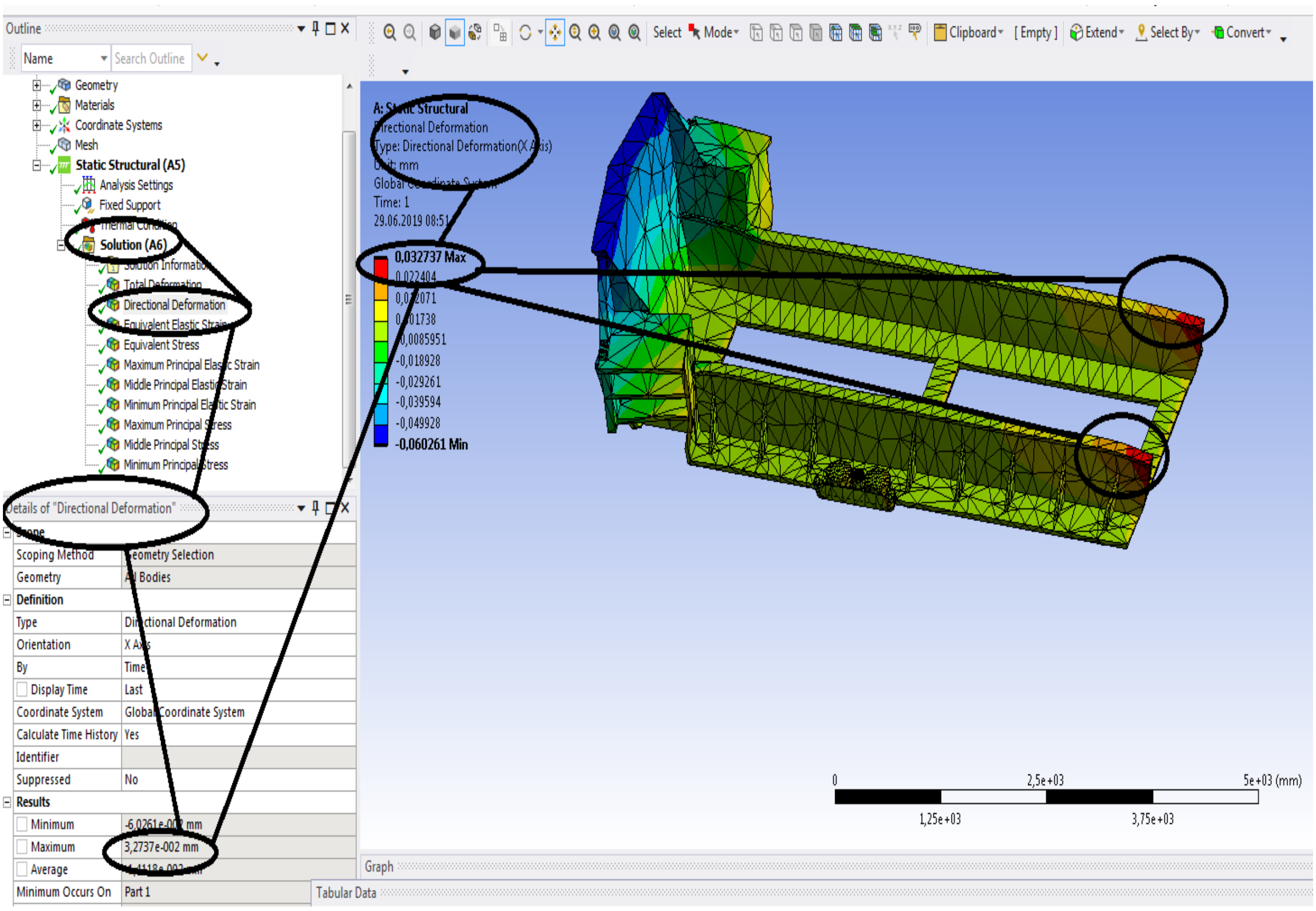


Figura 168 -Deformații direcționale pe axa x [mm]

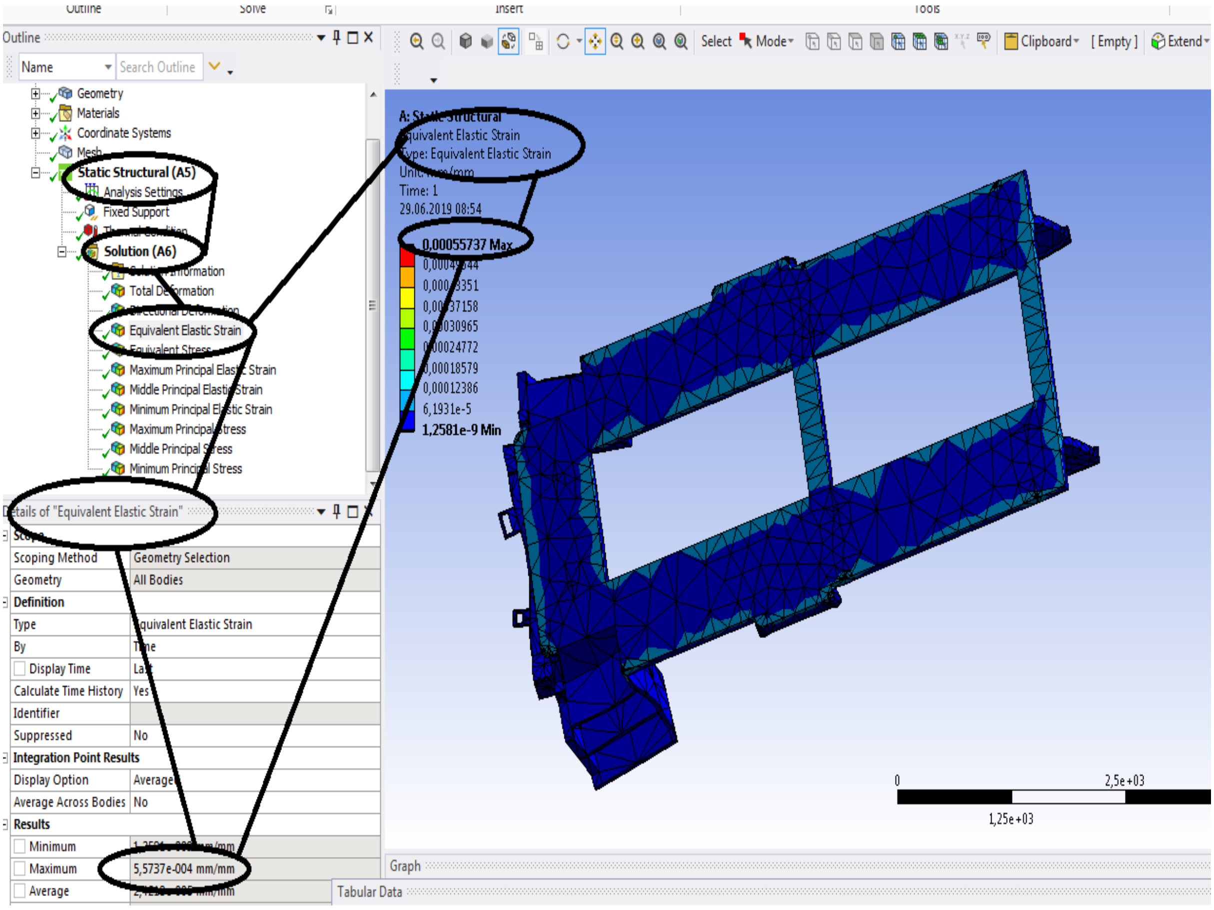


Figura 169 - Deformațiile specifice echivalente ε [mm/mm]

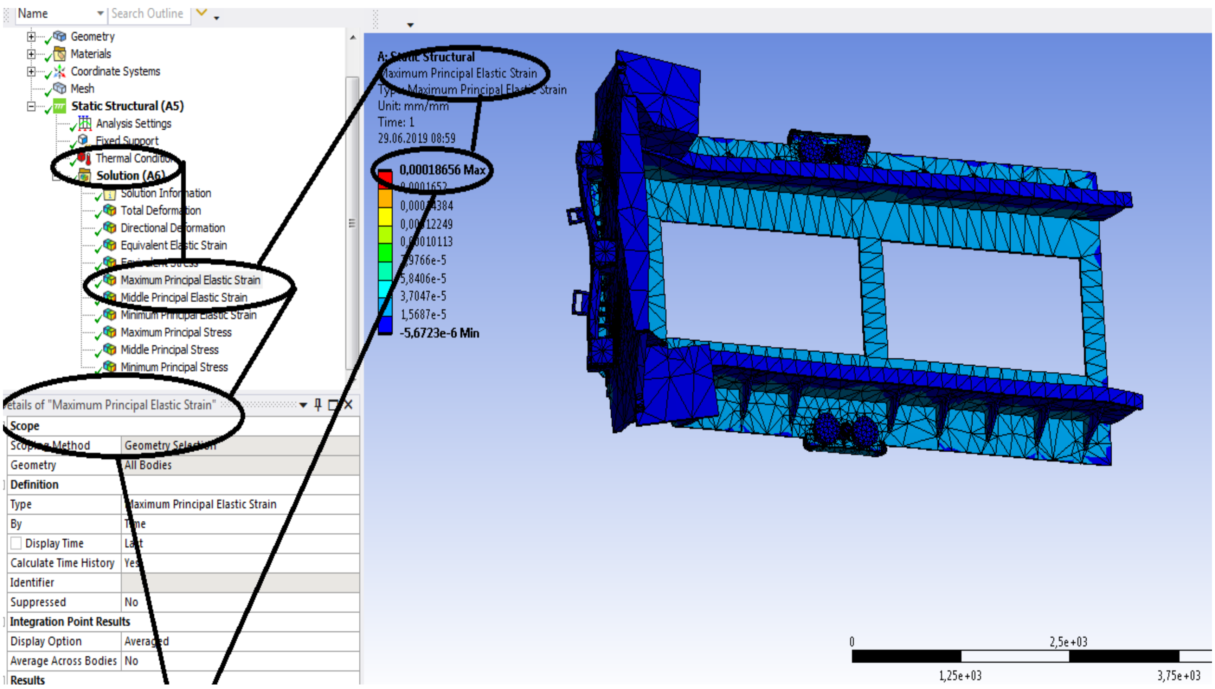


Figura 170 - Deformațiile specifice principale - ε1 [mm/mm]

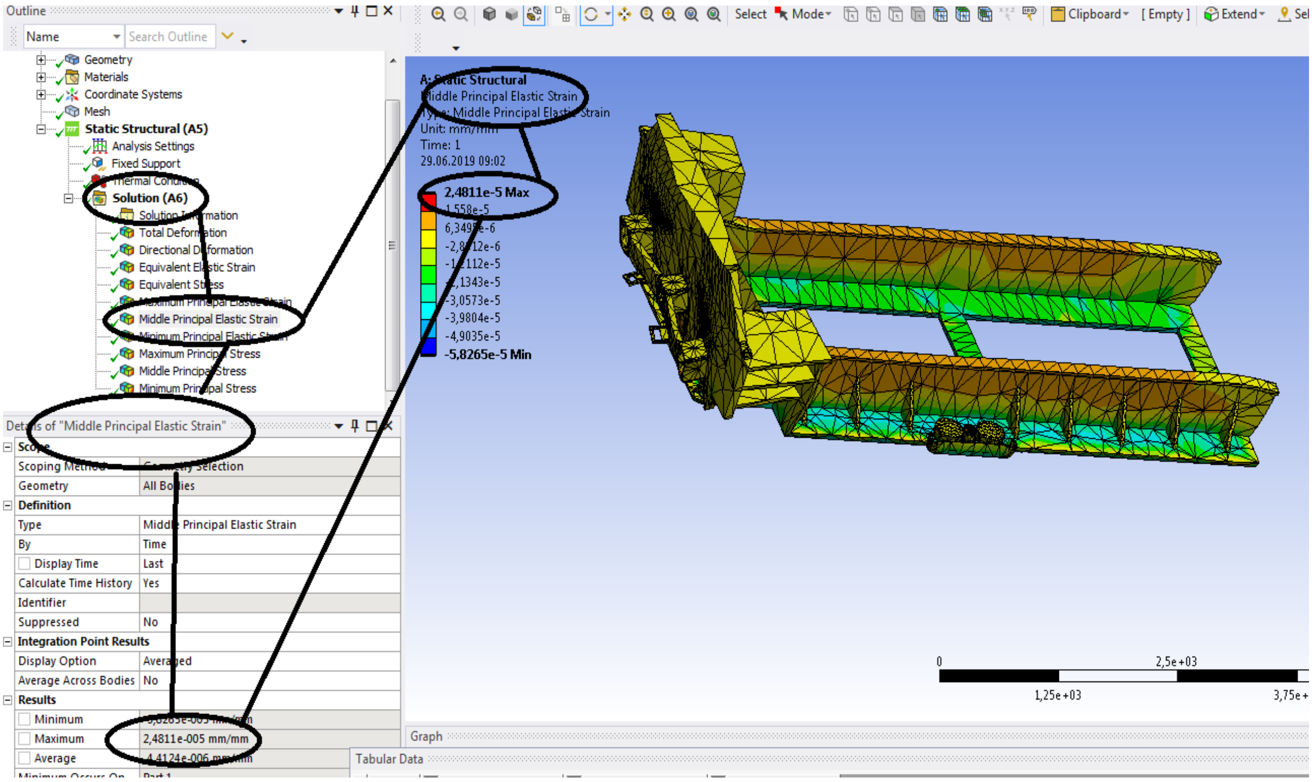


Figura 171 - Deformațiile specifice principale $\varepsilon 2$ [mm/mm]

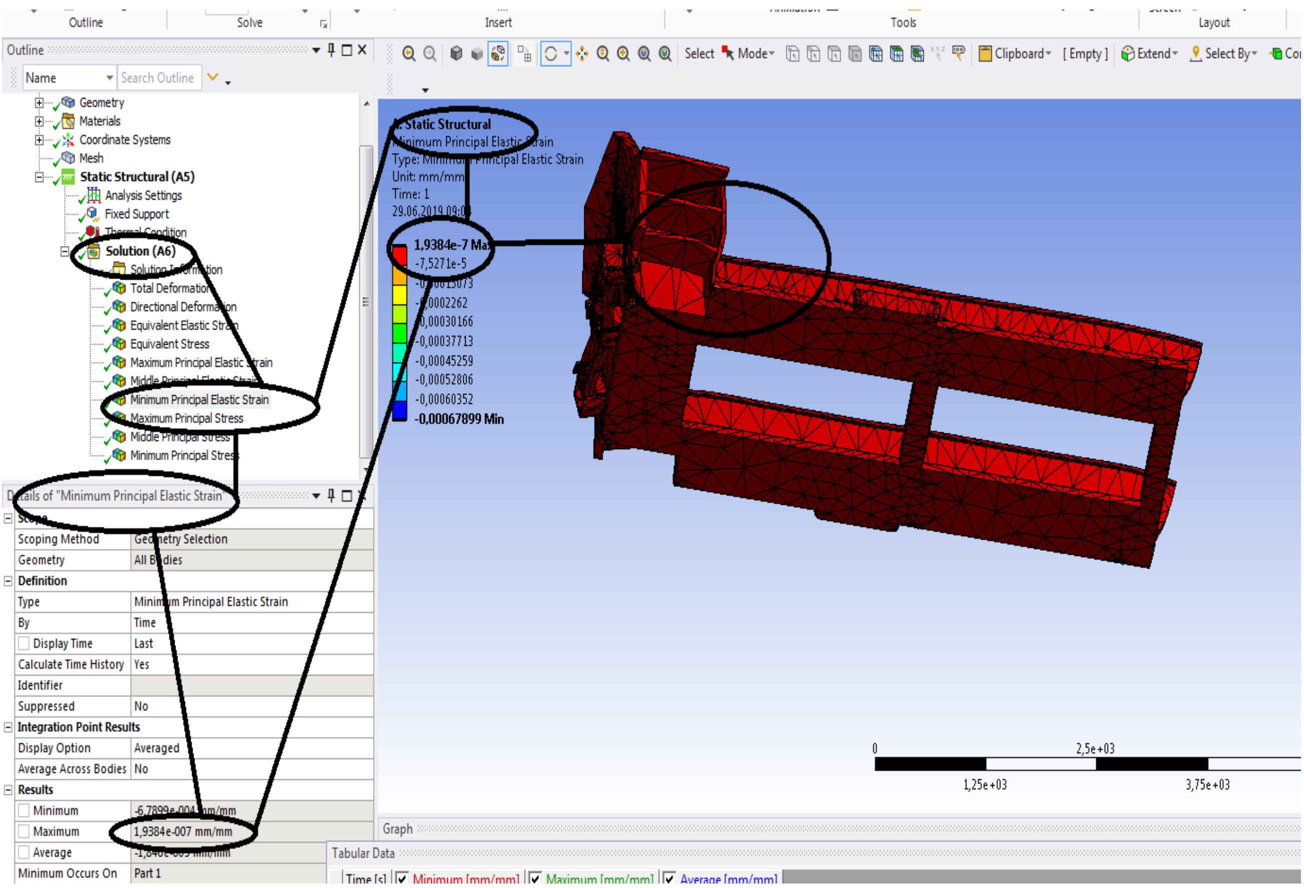


Figura 172 - Deformațiile specifice principale $\varepsilon 3$ [mm/mm]

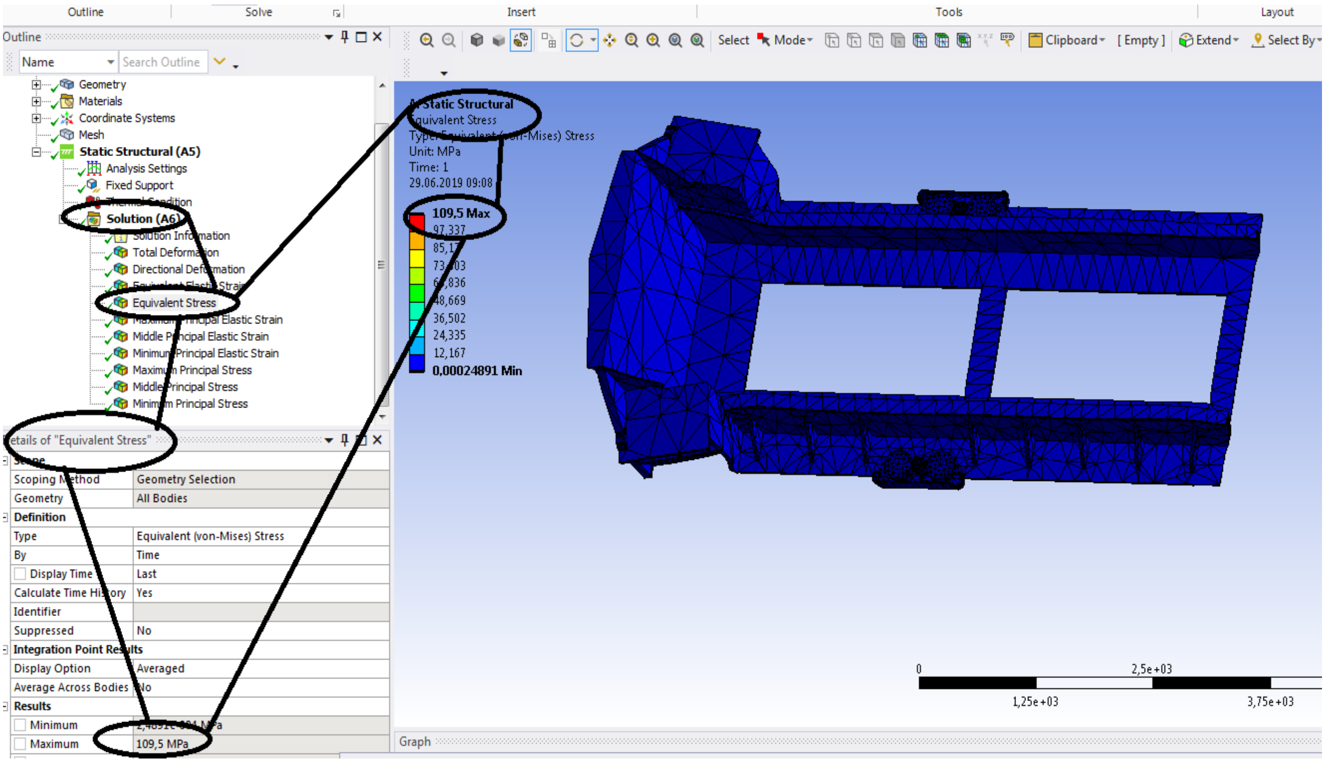


Figura 173 - Tensiunile echivalente von Mises [MPa]

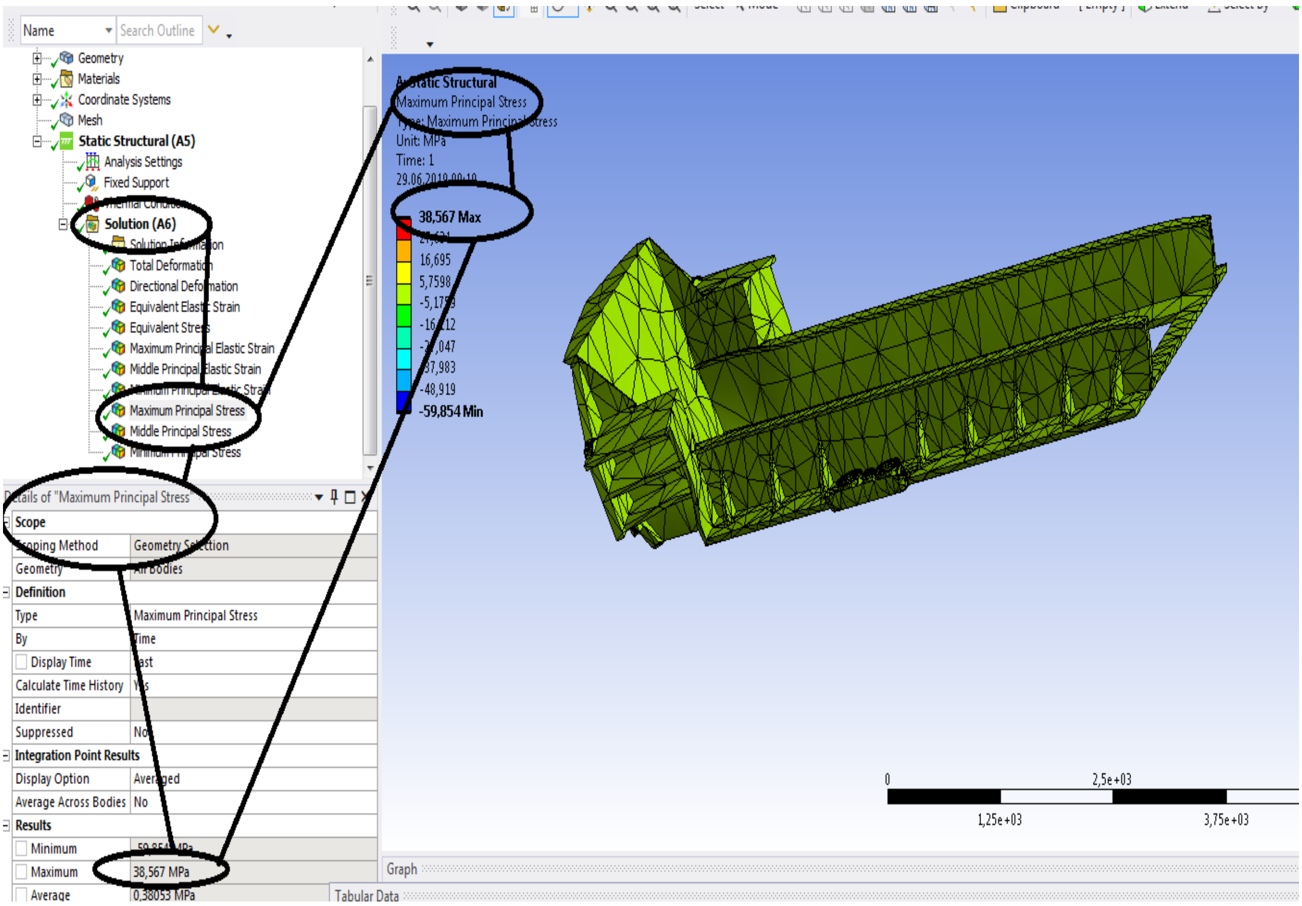


Figura 174 - Tensiunile principale $\sigma 1$ [MPa]

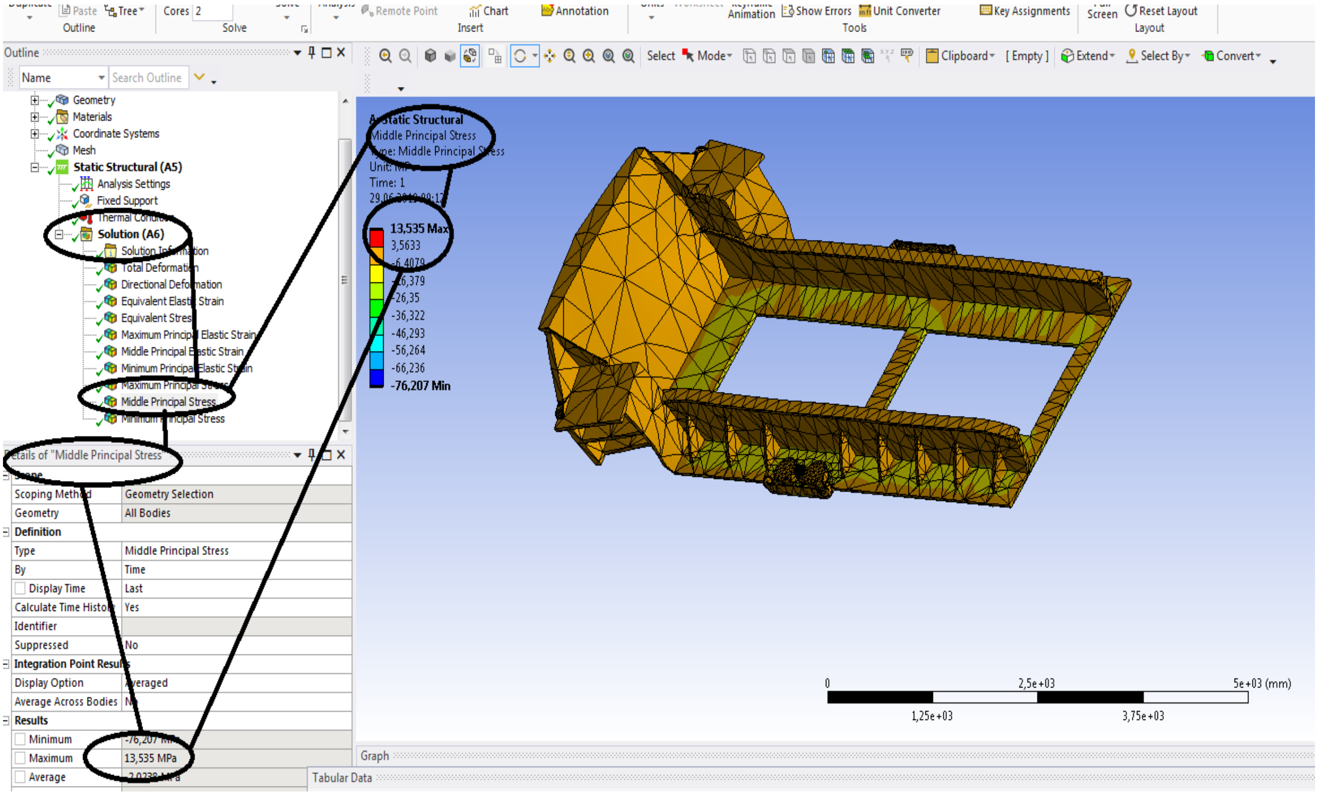


Figura 175 - Tensiunile principale $\sigma2$ [MPa]

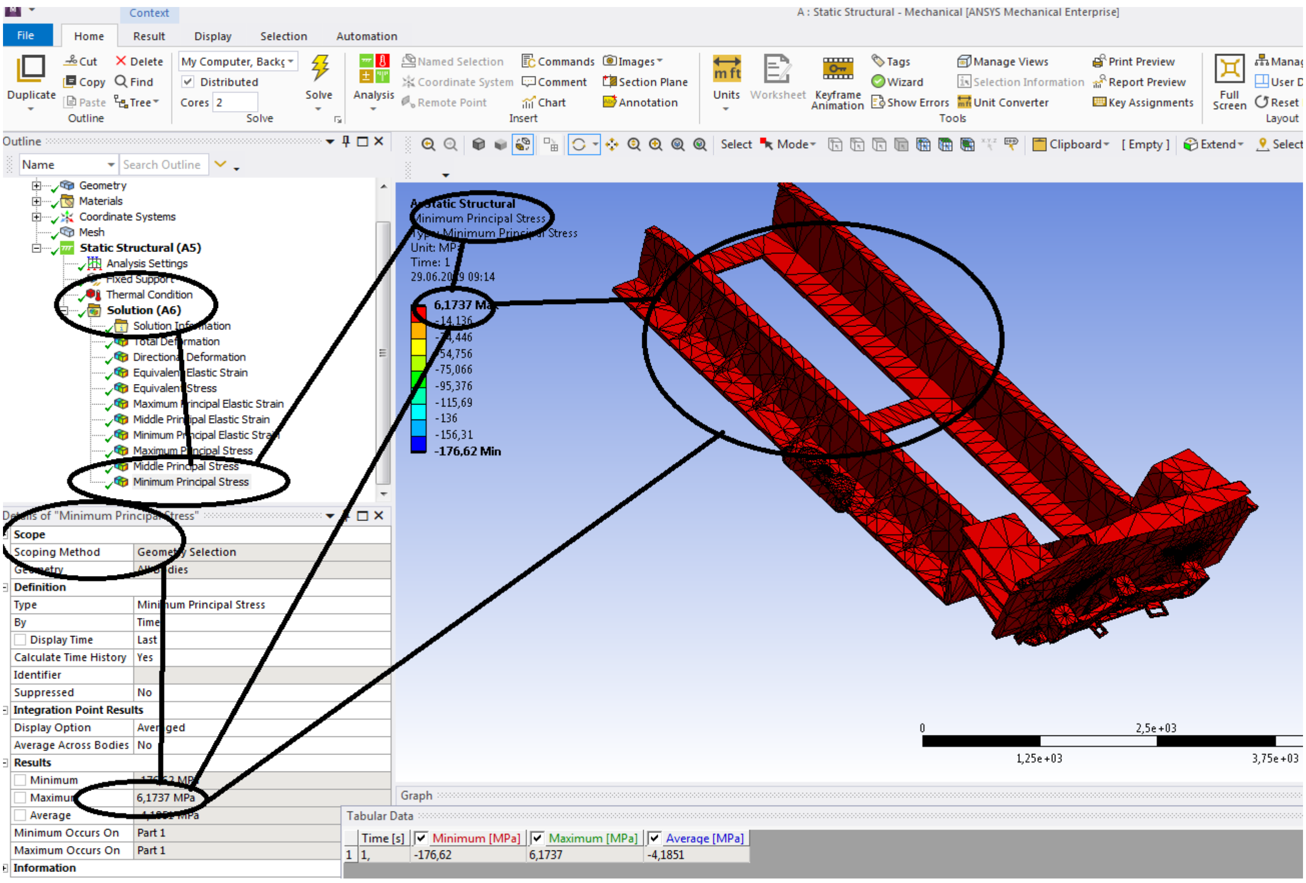


Figura 176 -Tensiunile principale $\sigma3$ [MPa]

2.5 Static structural mecanic si termic pentru sasiu

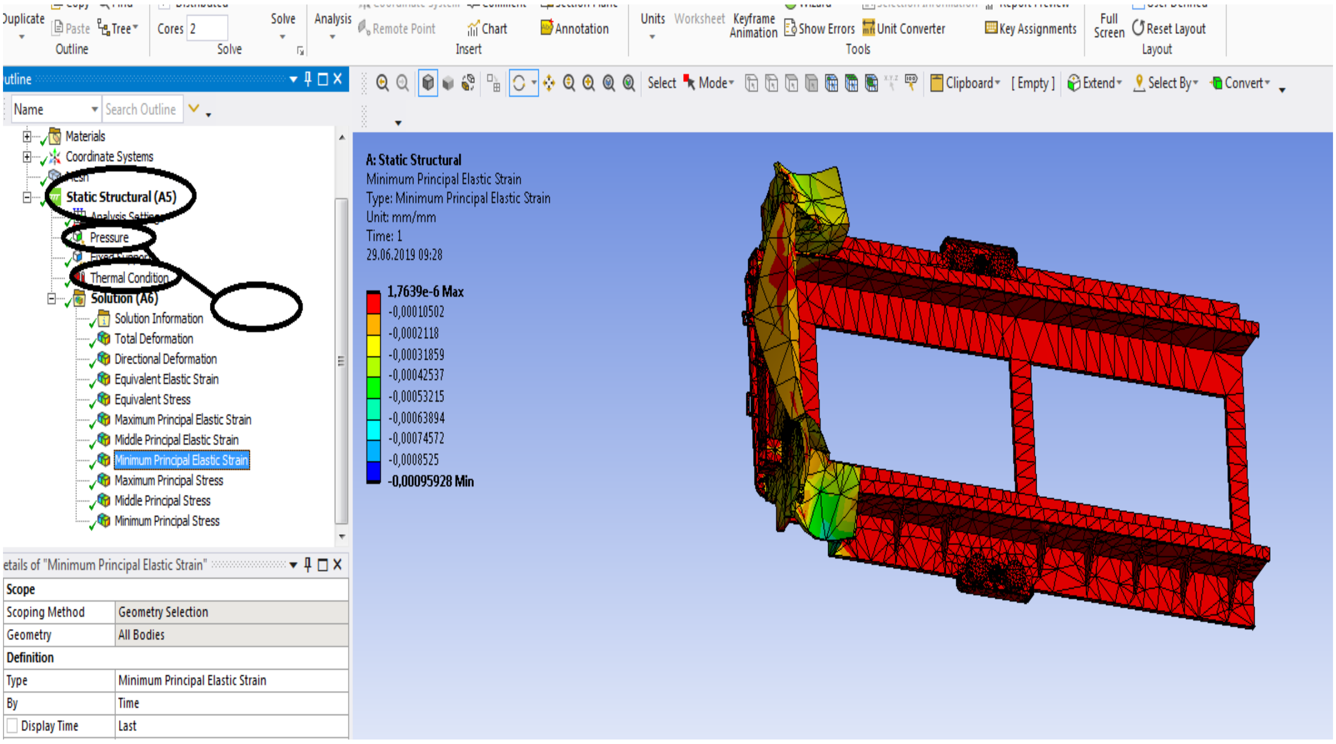


Figura 177 –Solution (A6)- Solve – Get Results

2.6 Rezultatele de la static structural mecanic si termic pentru sasiu

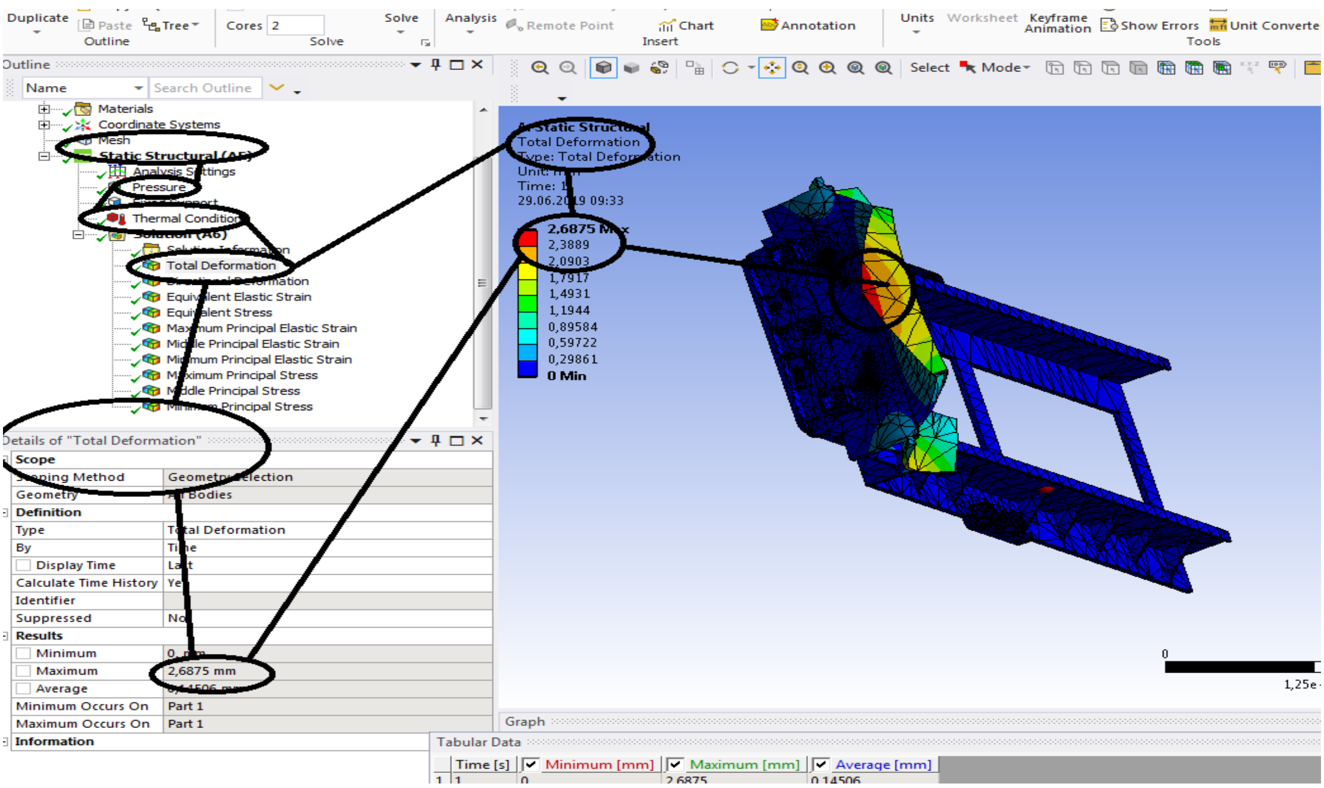


Figura 178 - Deformații totale [mm]

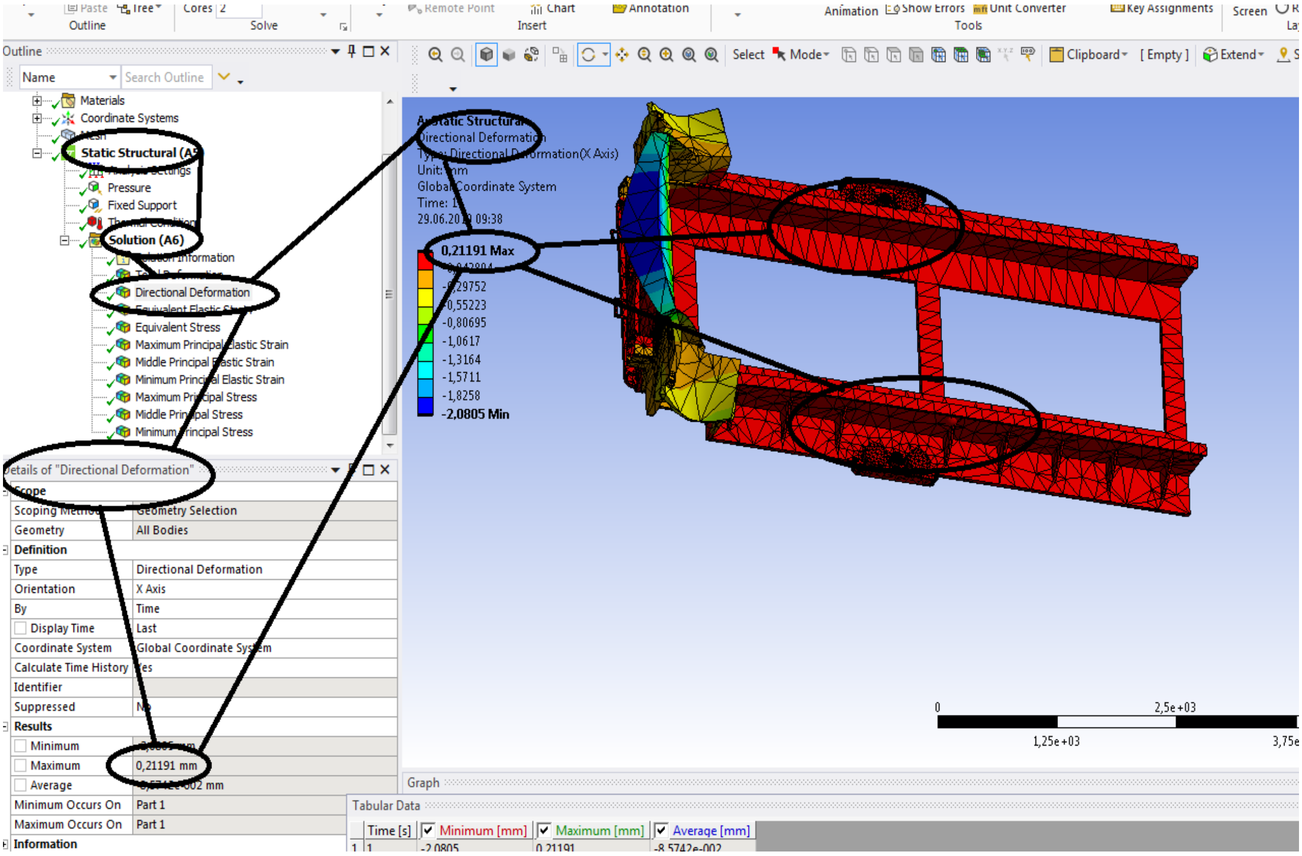


Figura 179 - Deformații direcționale pe axa x [mm]

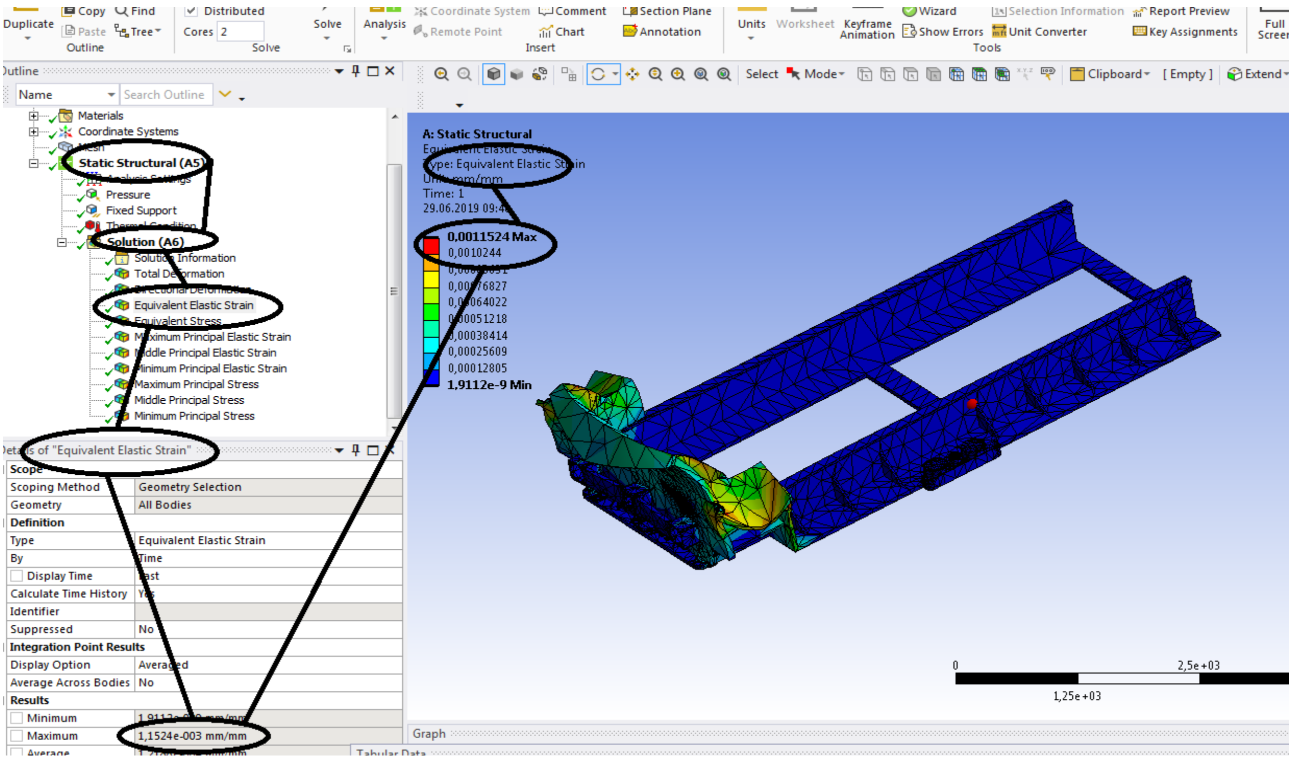


Figura 180 - Deformațiile specifice echivalente ε [mm/mm]

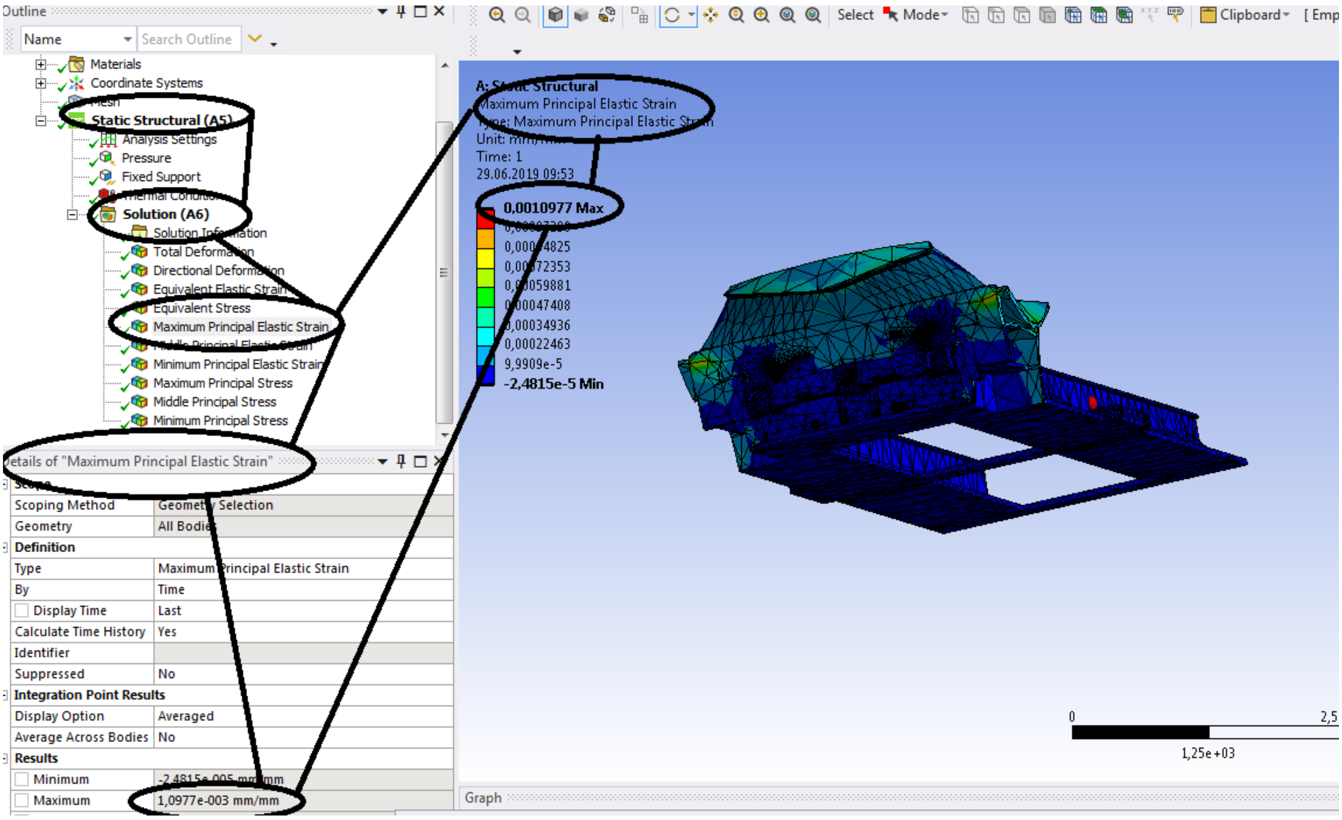


Figura 181 - Deformațiile specifice principale - ε1 [mm/mm]

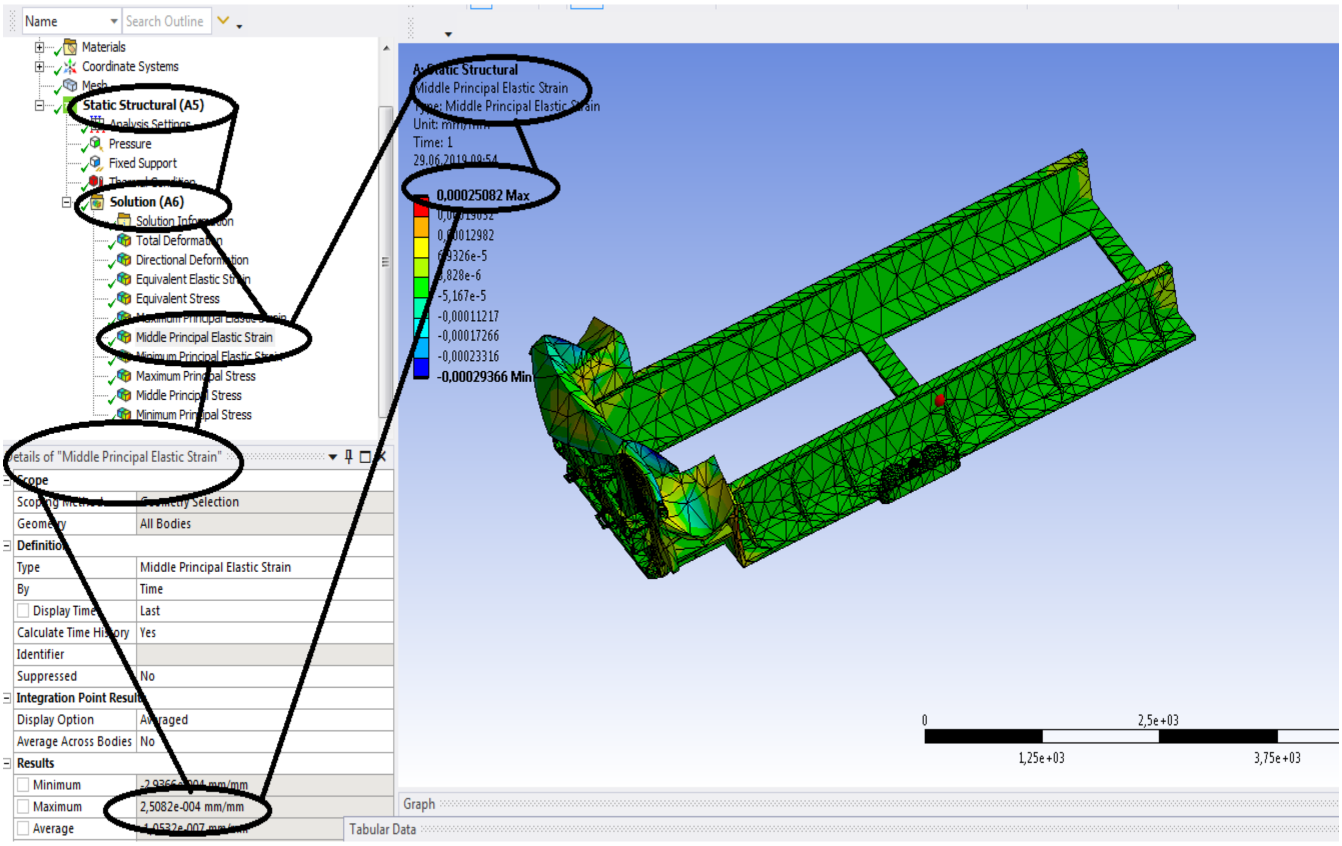


Figura 182 - Deformațiile specifice principale ε2 [mm/mm]

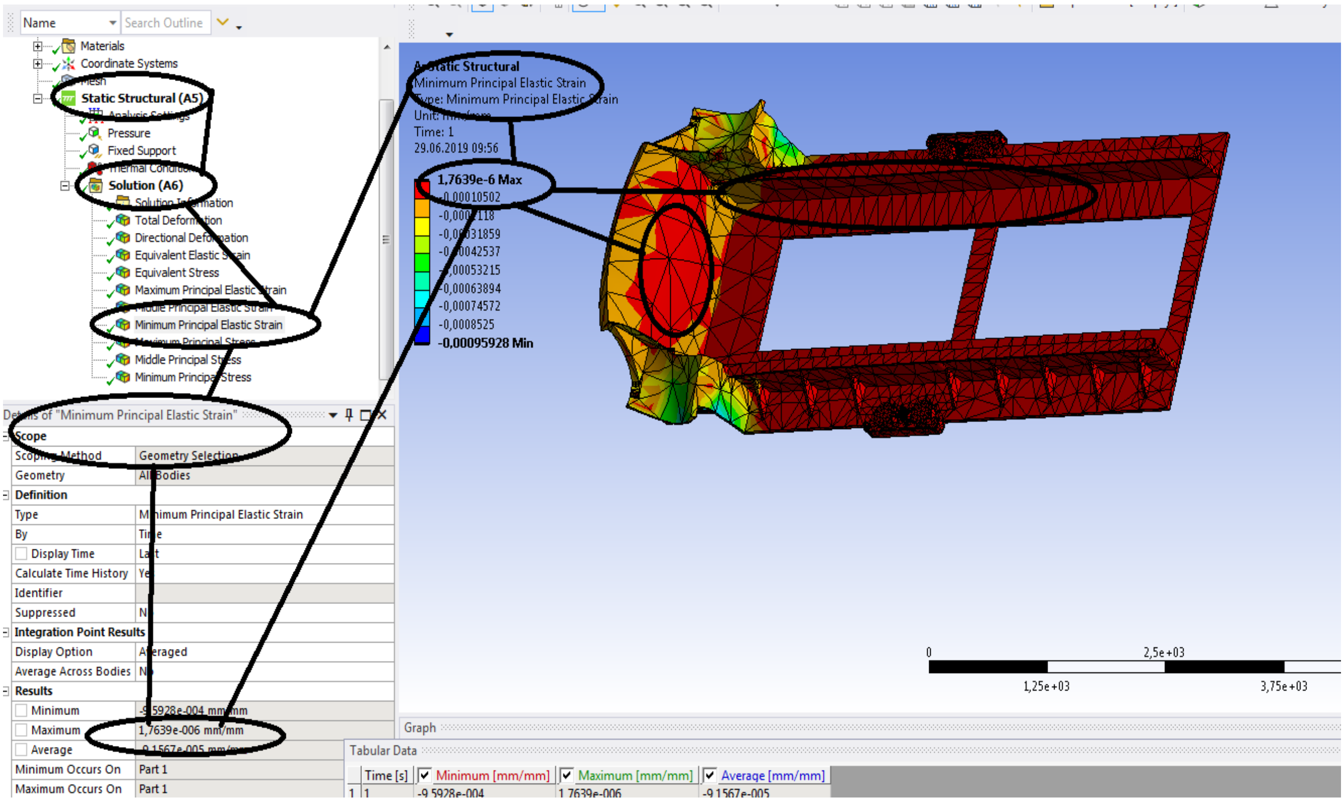


Figura 183 - Deformațiile specifice principale ε3 [mm/mm]

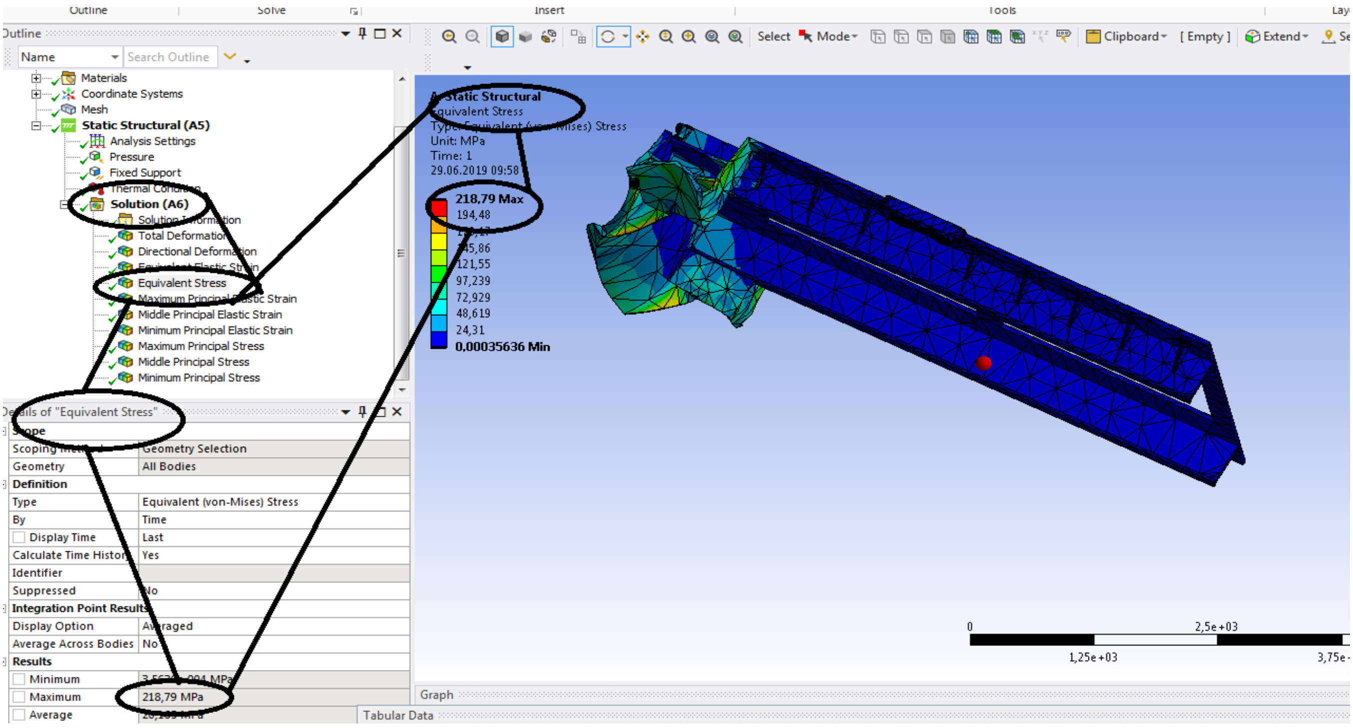


Figura 184 - Tensiunile echivalente von Mises [MPa]

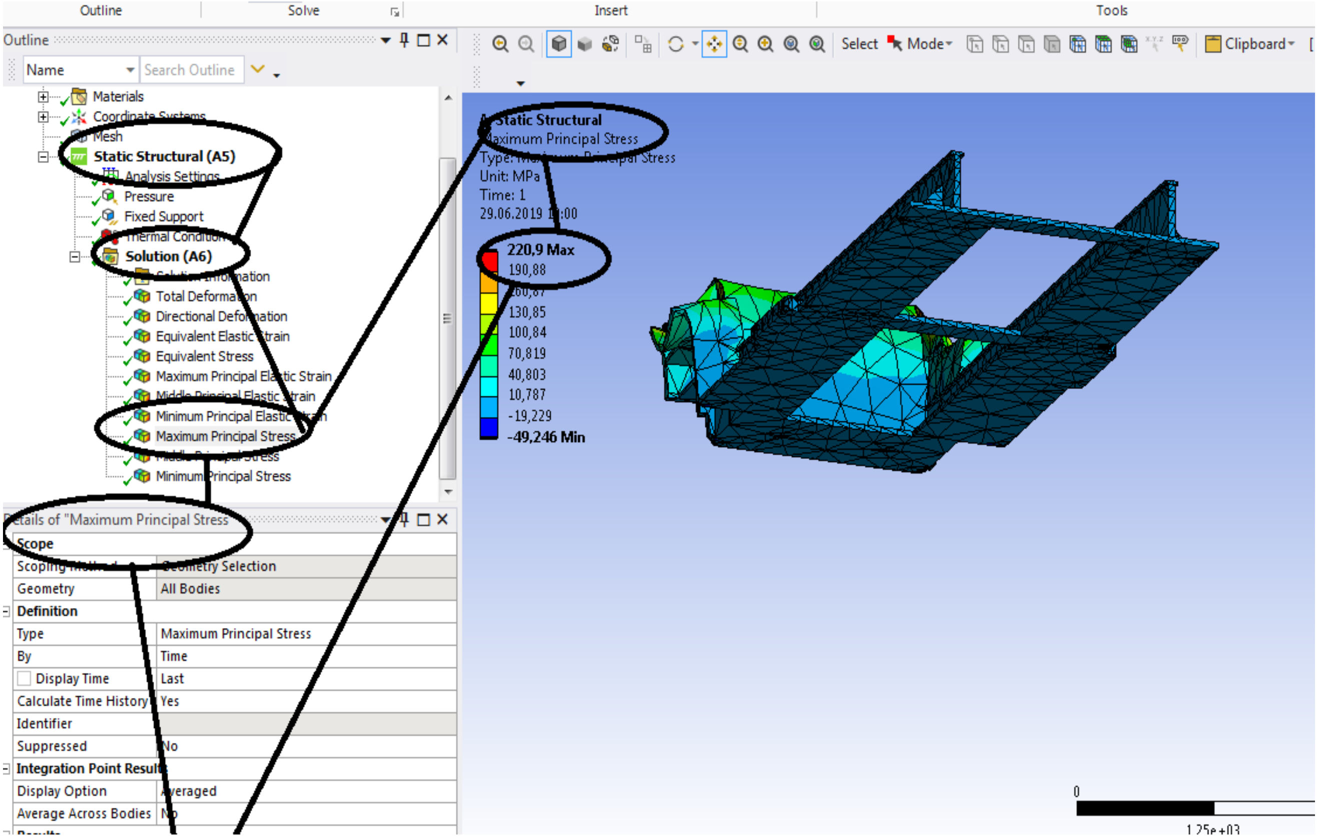


Figura 185 - Tensiunile principale $\sigma 1$ [MPa]

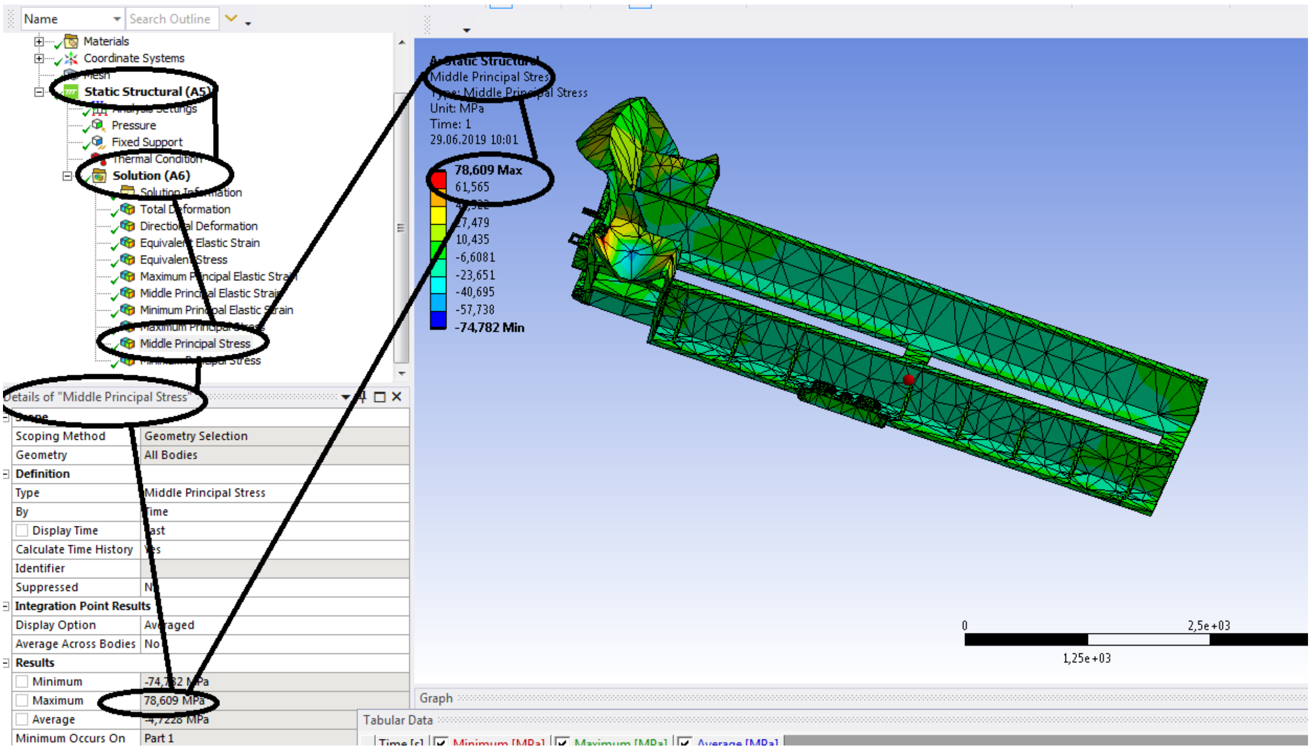


Figura 186 - Tensiunile principale $\sigma 2$ [MPa]

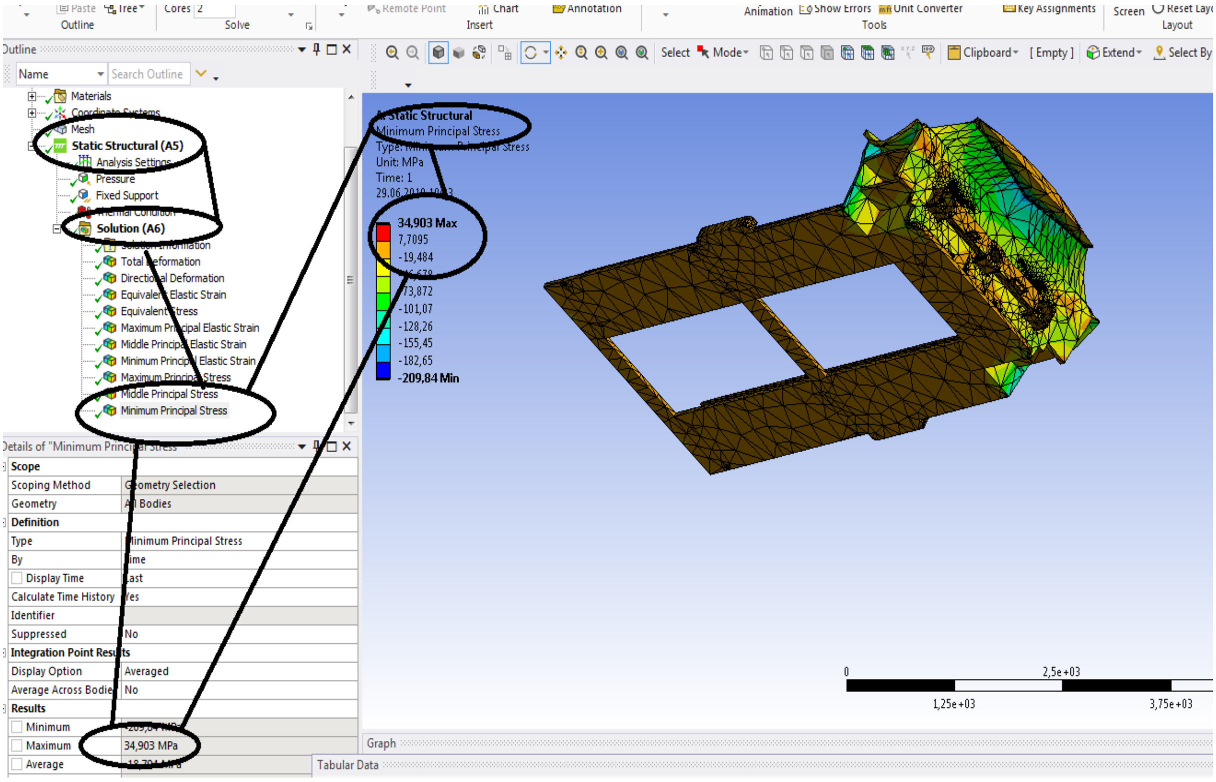


Figura 187 -Tensiunile principale $\sigma 3$ [MPa]

2.7 Solicitarea la oboseala a sasiului

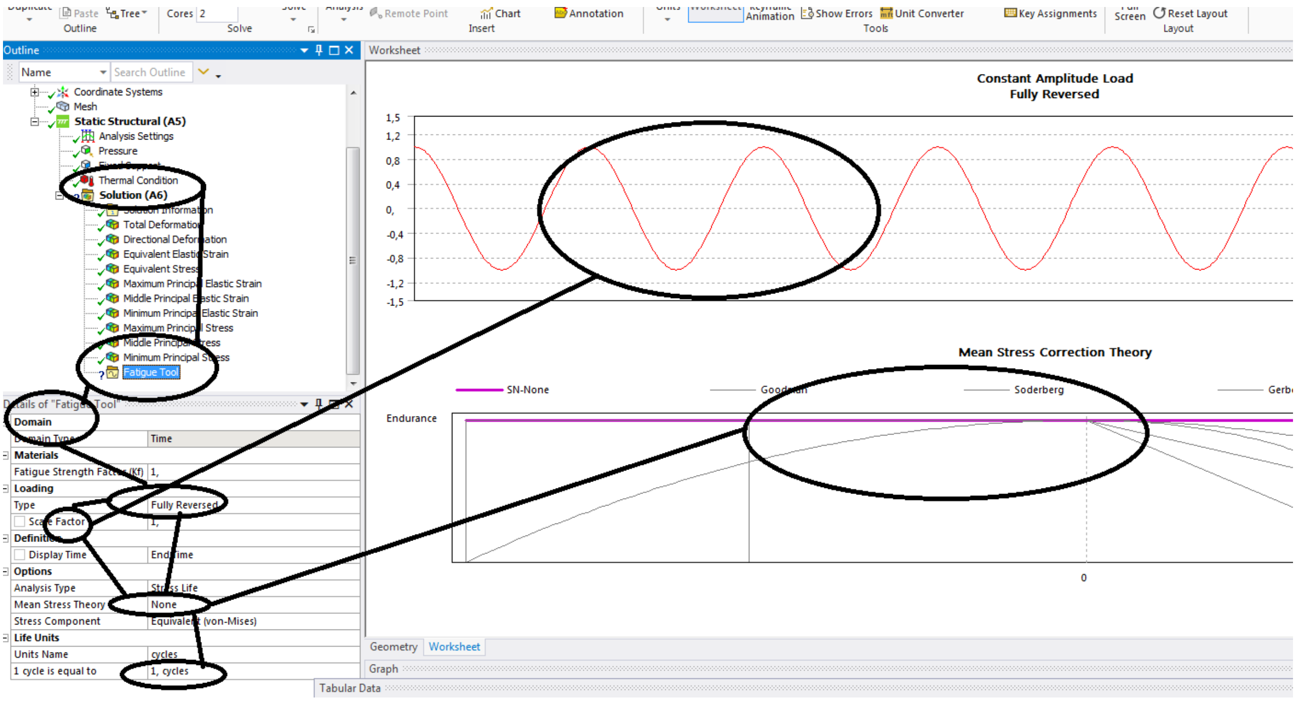


Figura 188 – R = -1 , Soderberg

-s-a ales R = -1 ; Soderberg si 1.000.000 de cicluri;

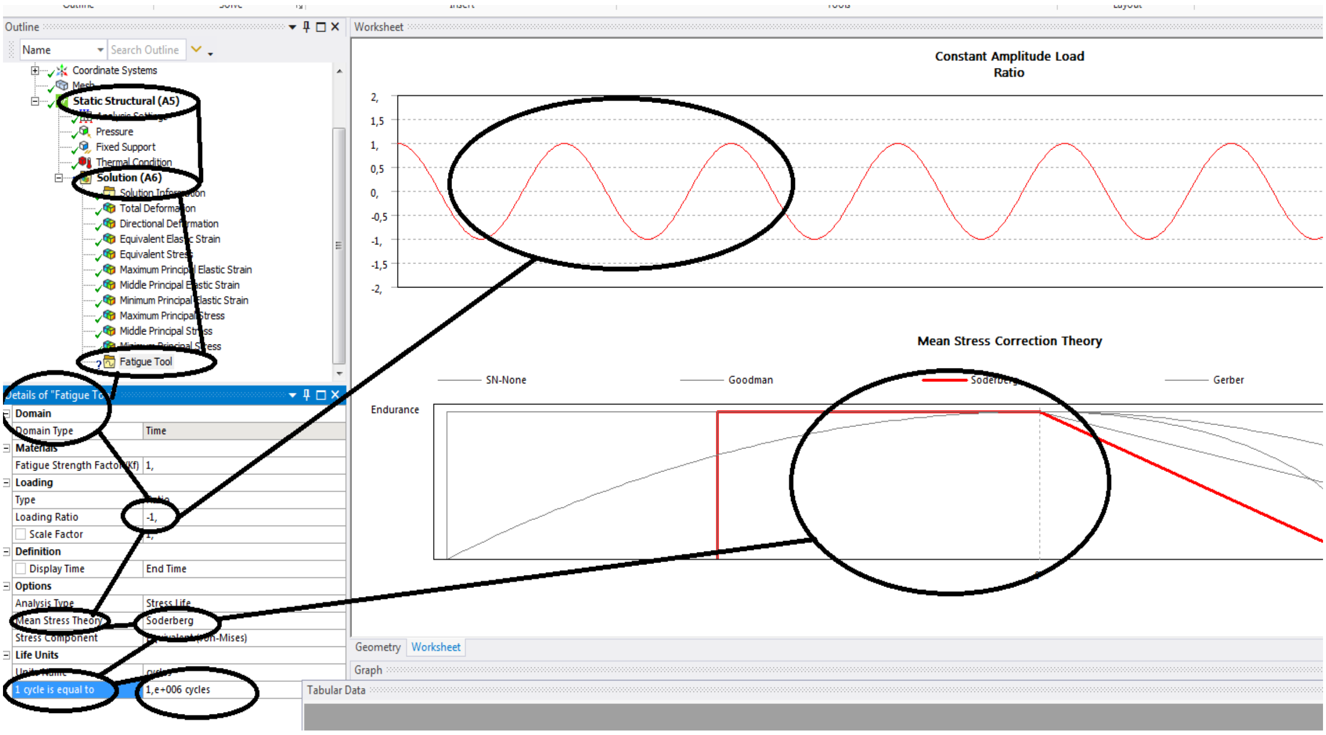


Figura 189 – R = -1 , Soderberg si numarul de cicluti 1000000

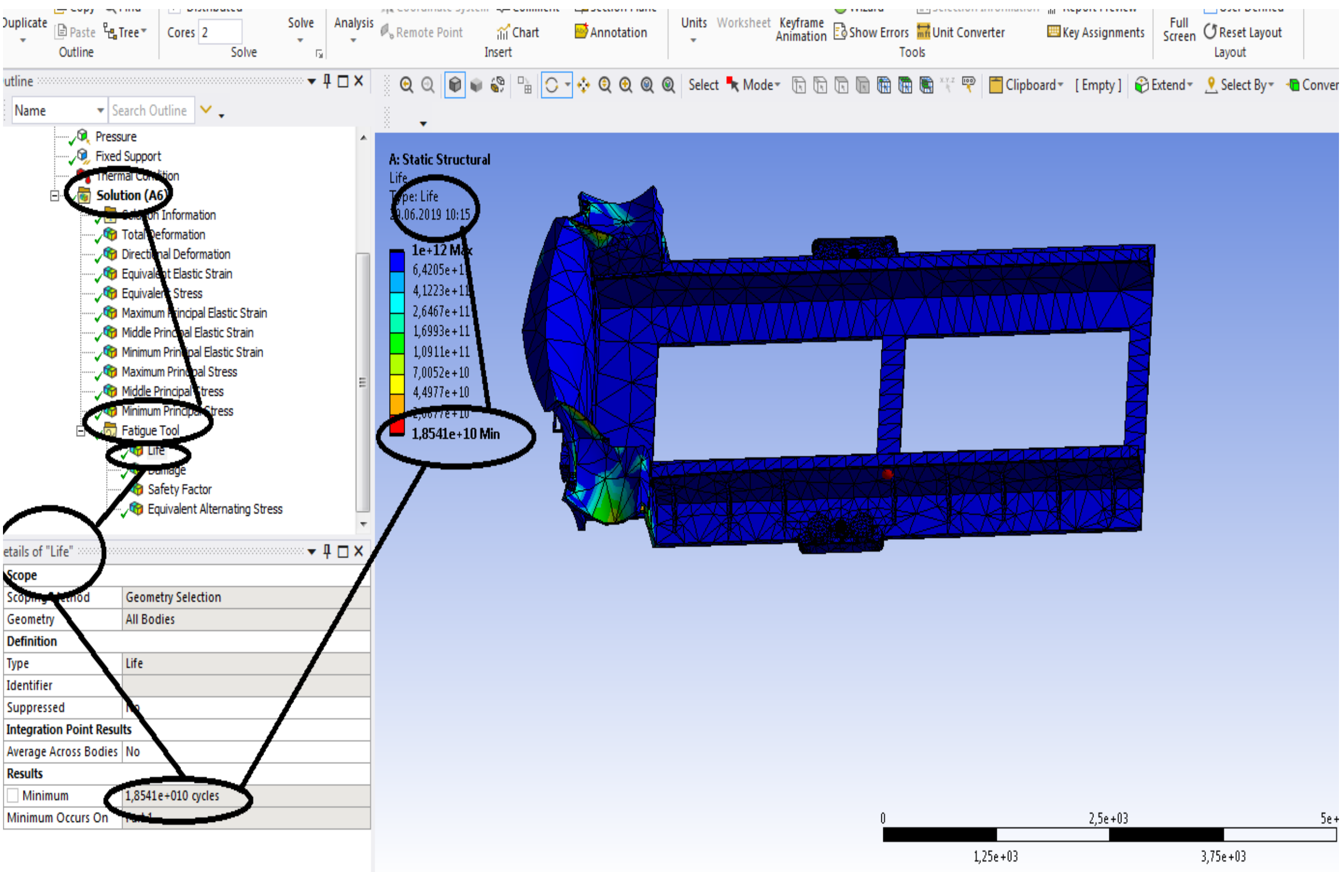


Figura 190 -durata de viata [s]

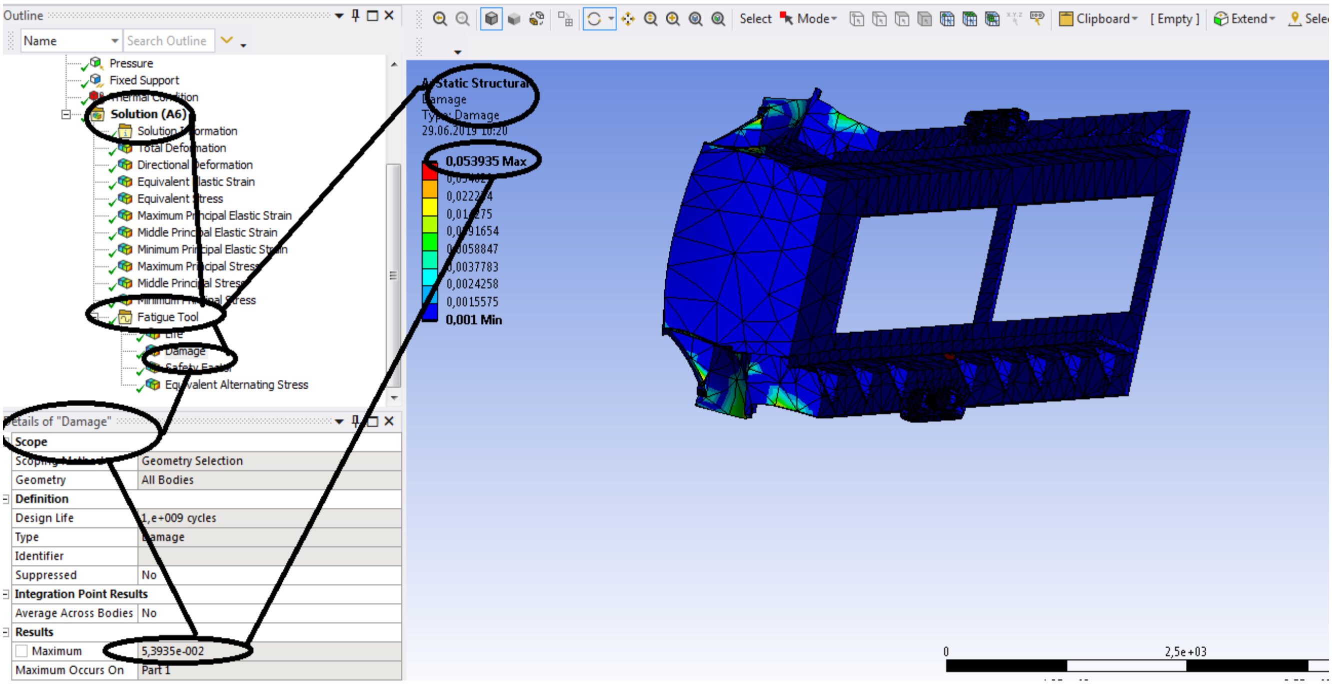


Figura 191 - avarii [s]

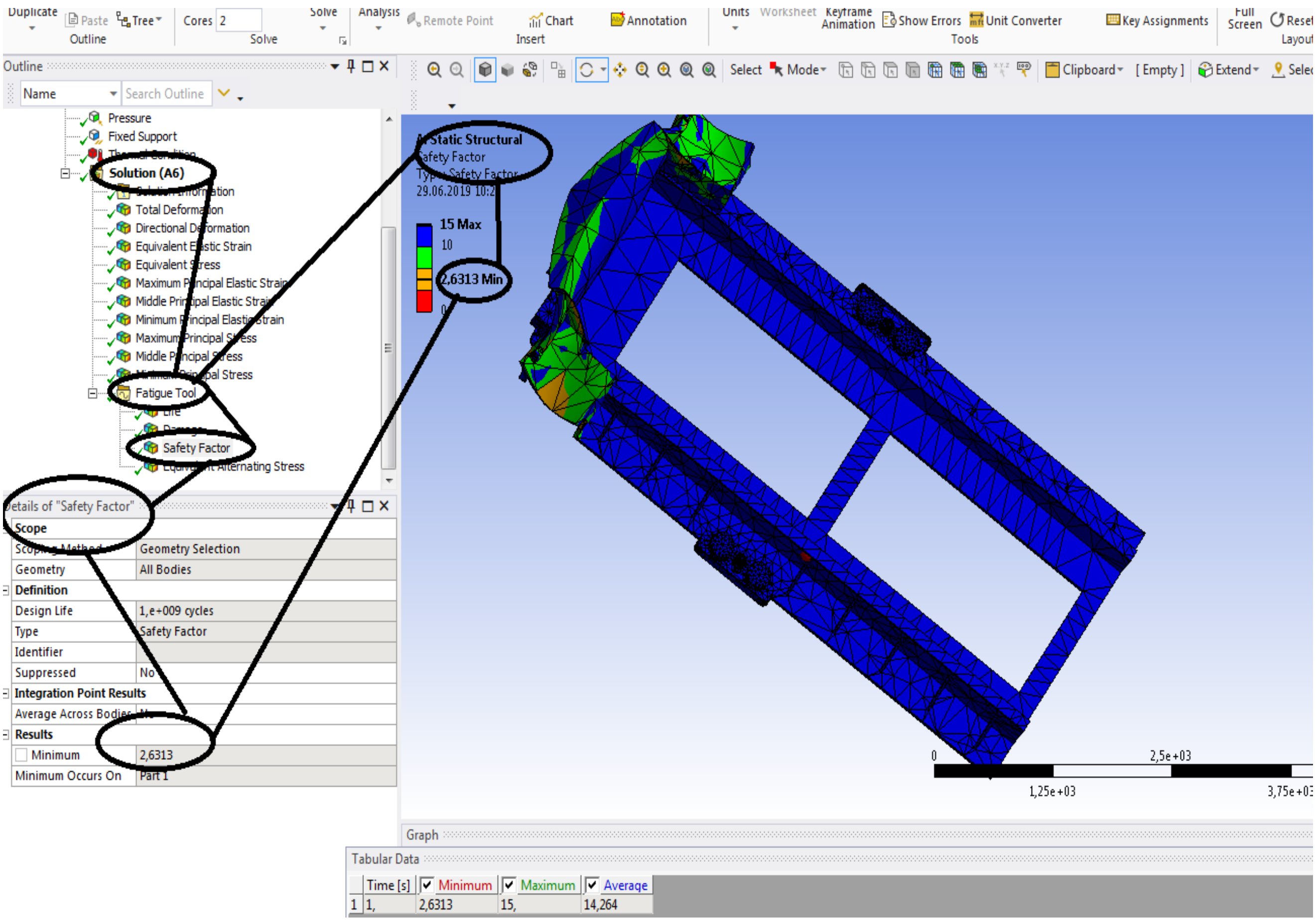


Figura 192 - coeficientii de siguranta

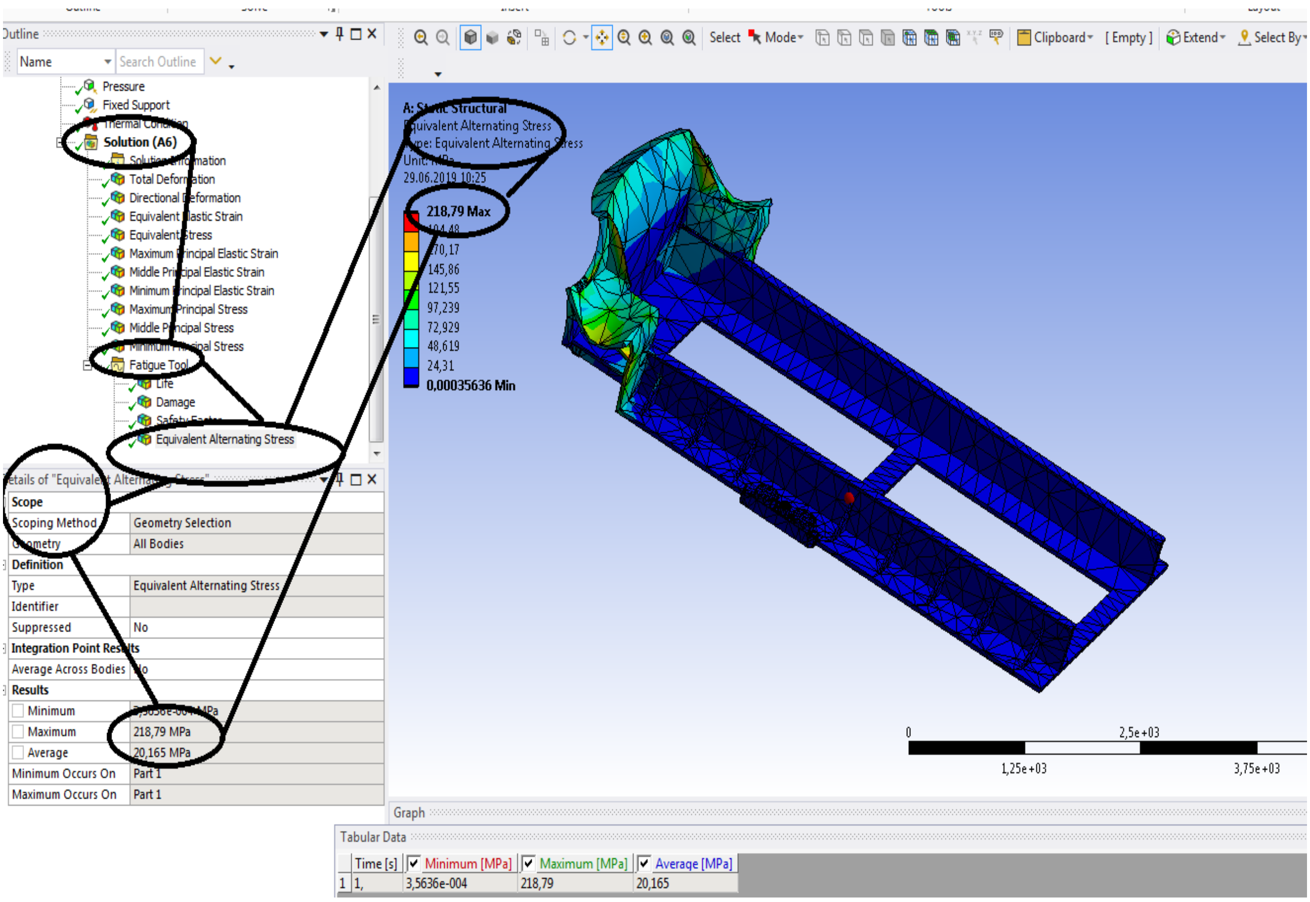


Figura 193 - tensiunea la oboseala [MPa]

2.8 Solicitarea la vibratii mecanice a sasiului

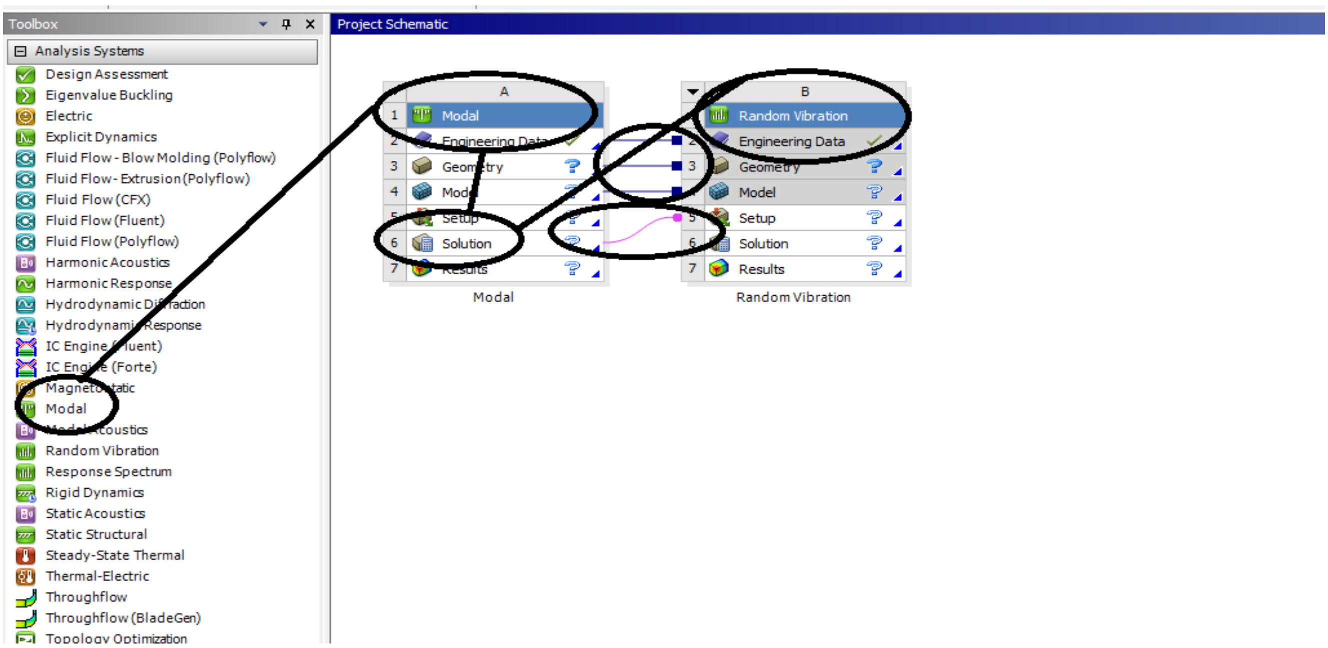


Figura 194 – Random Vibration

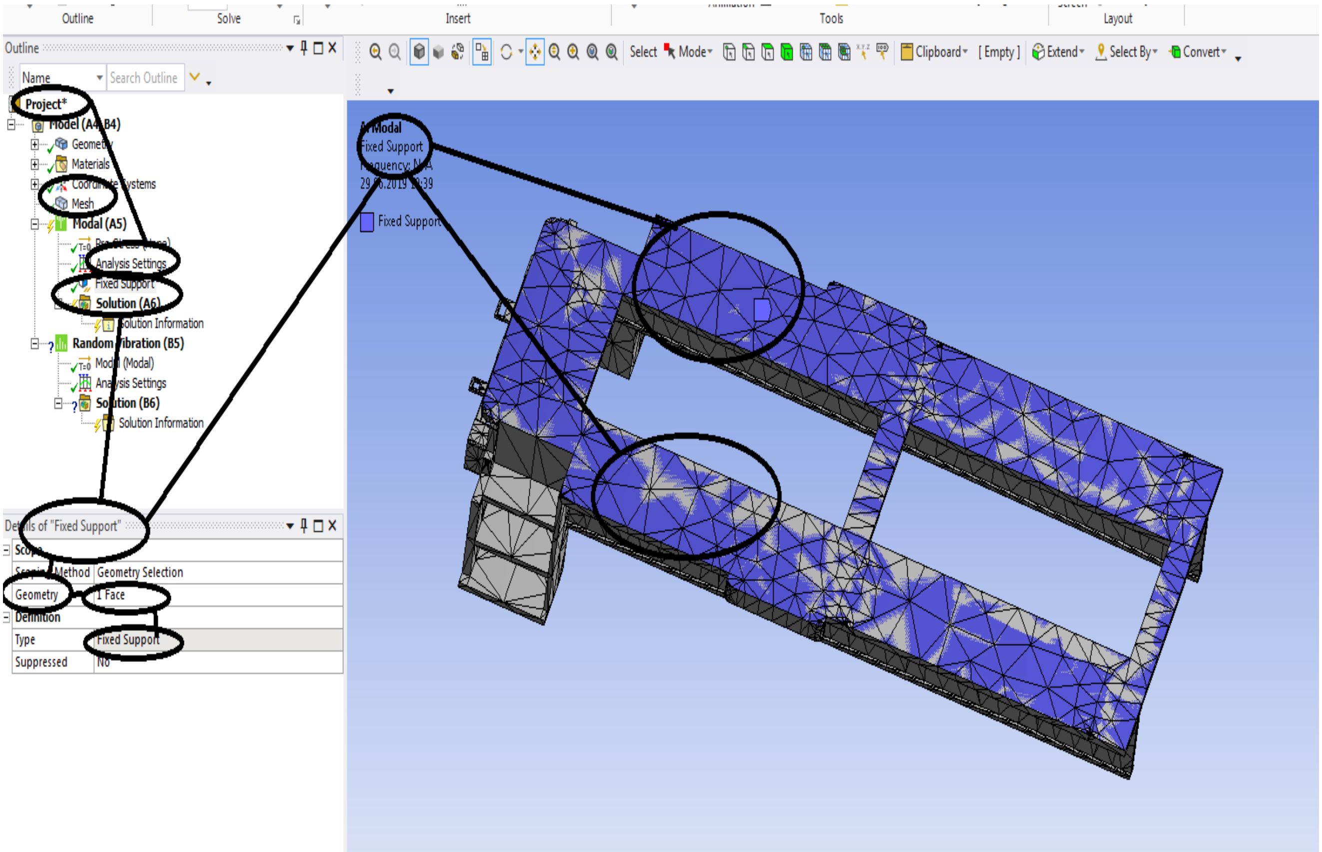


Figura 195 – Rezemarea sasiului

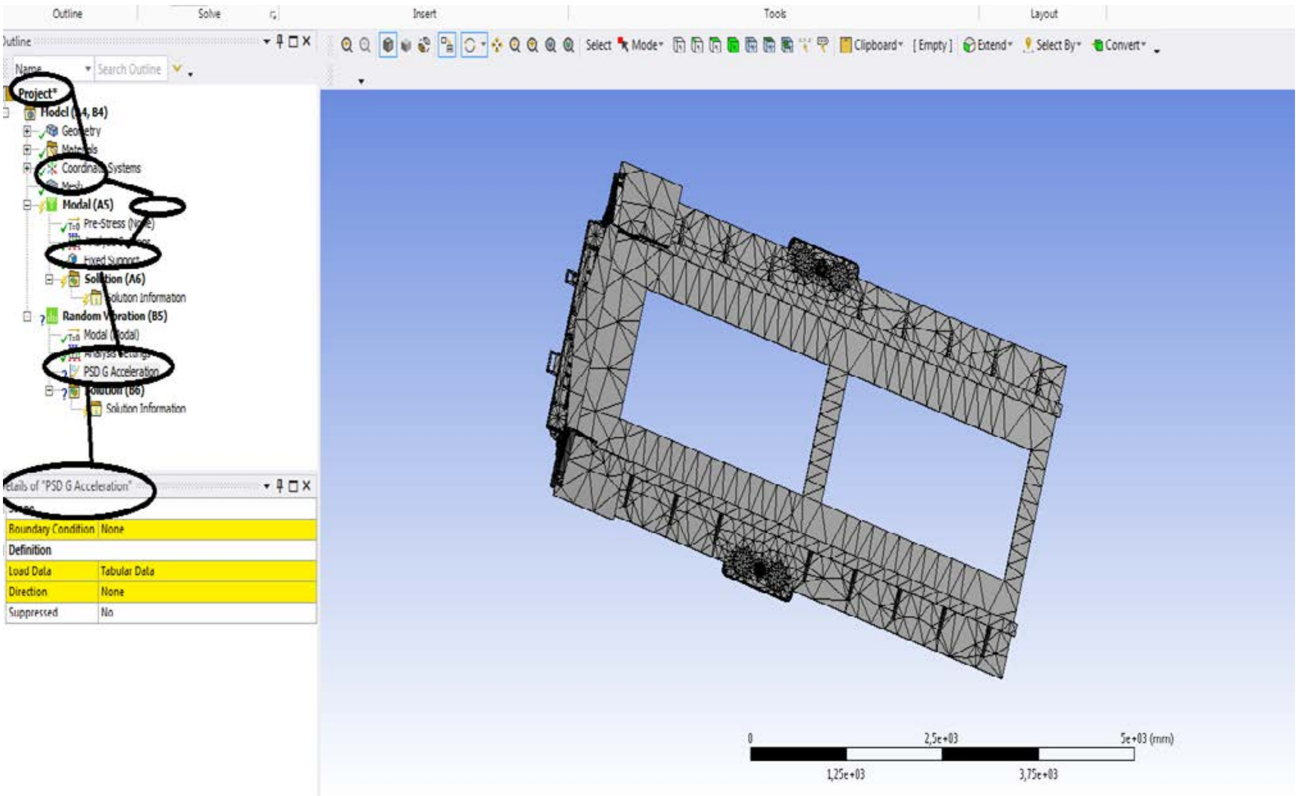


Figura 196 –Detail of „PSD G Acceleration”

Rezultate

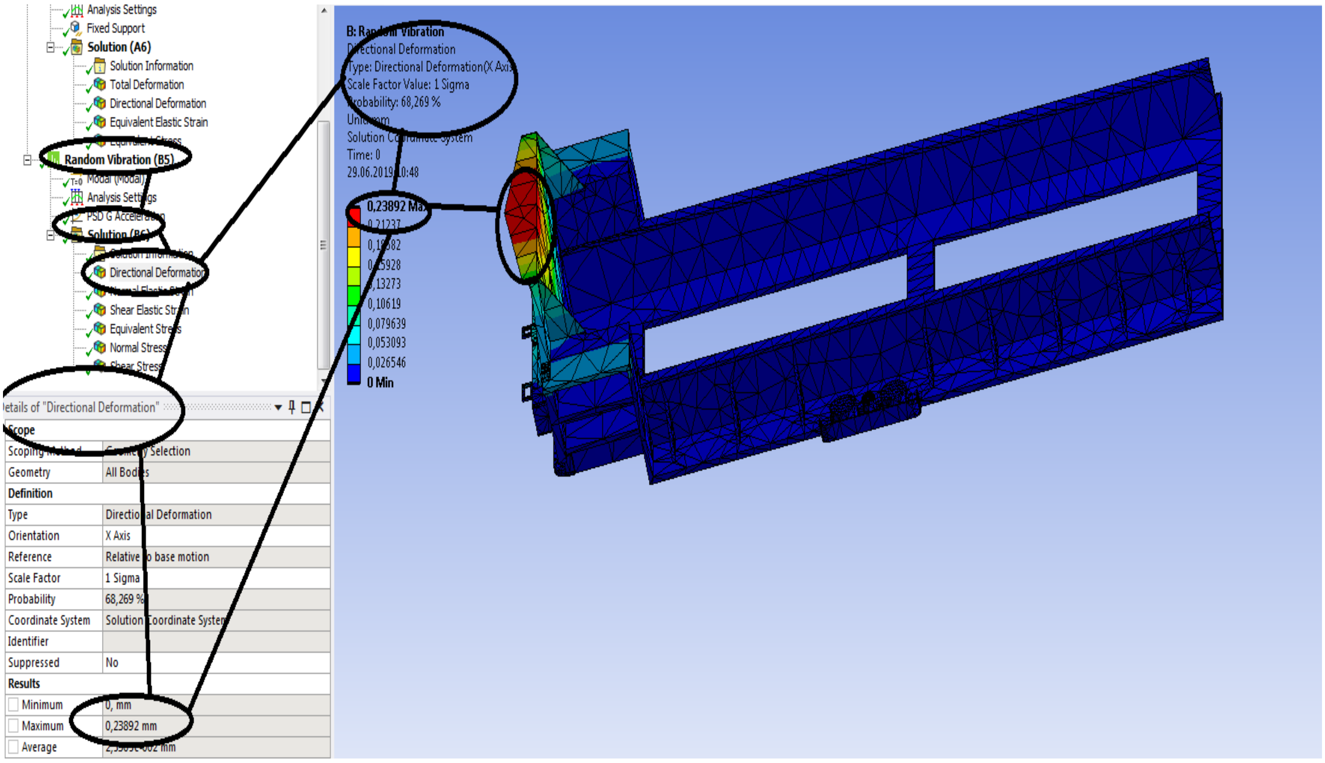


Figura 197 -Deformații direcționale pe axa x [mm]

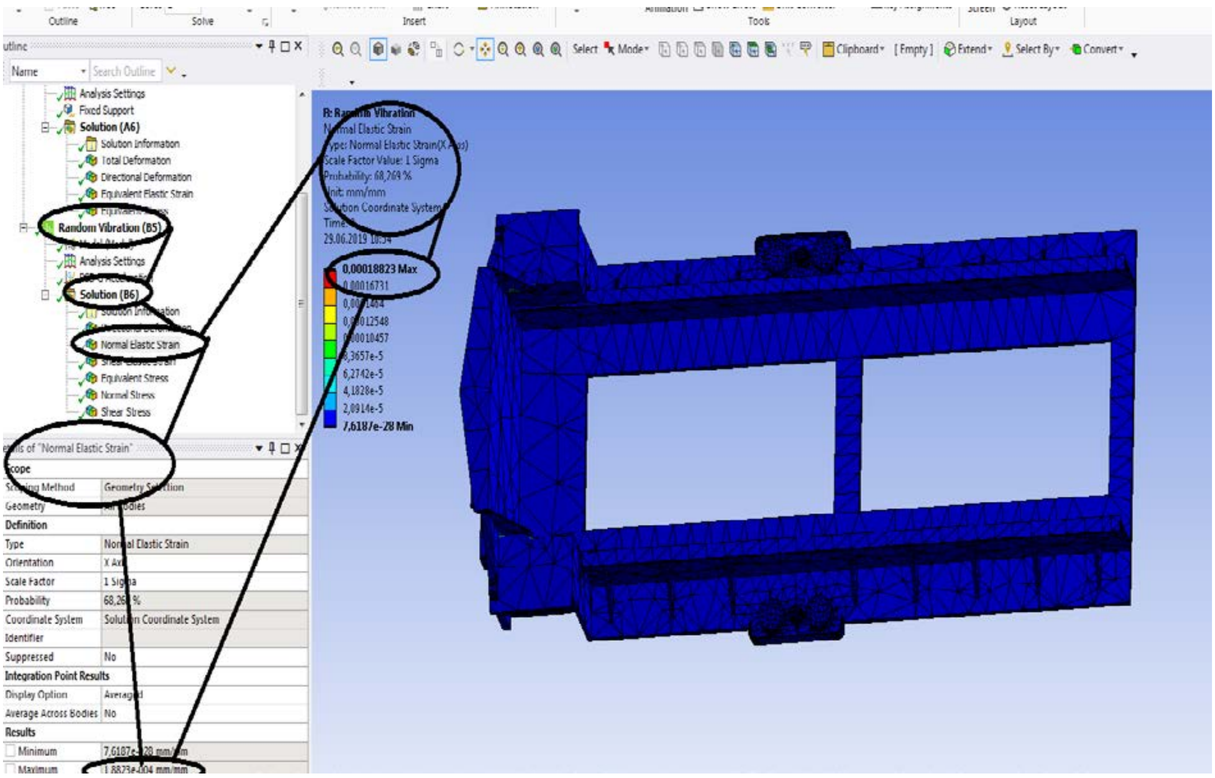


Figura 198 - Deformațiile normale specifice (dupa axa OX) [mm/mm]

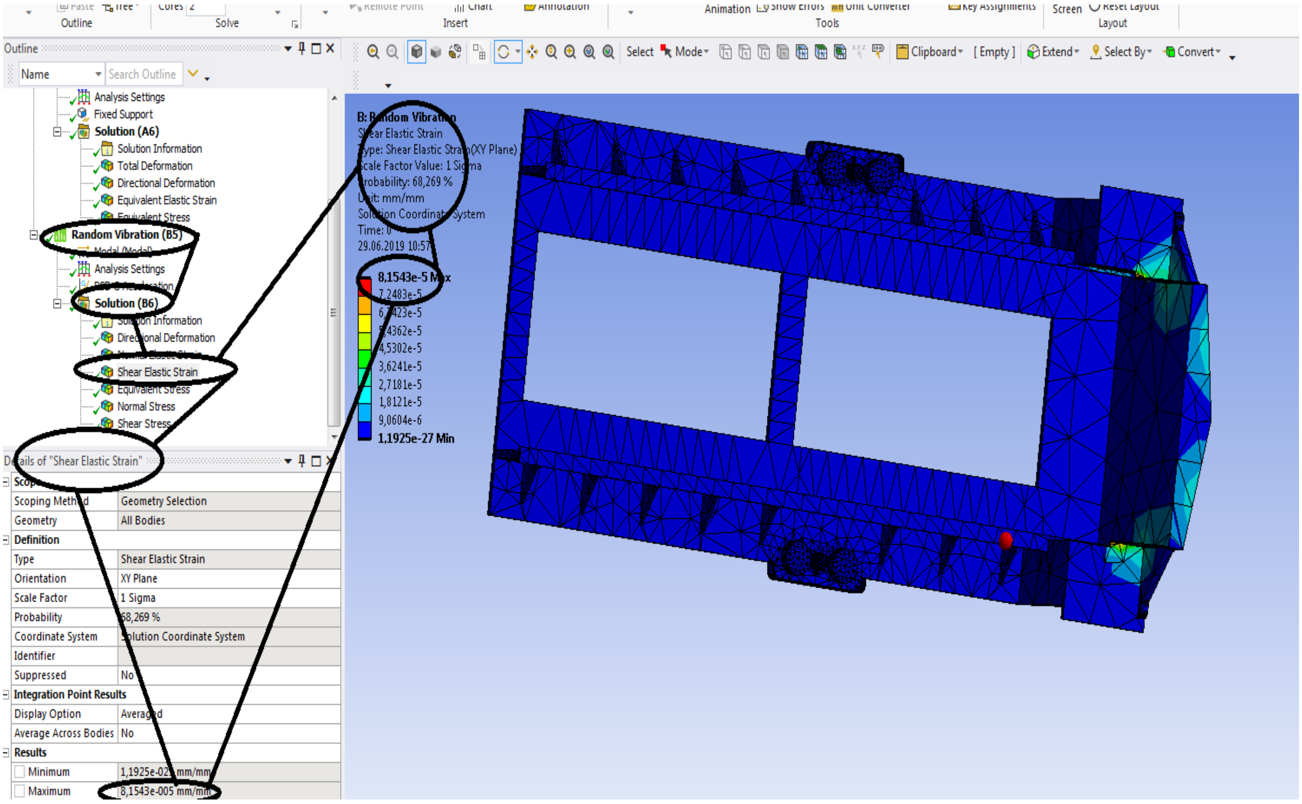


Figura 199 - lunecarile specifice in planul XOY

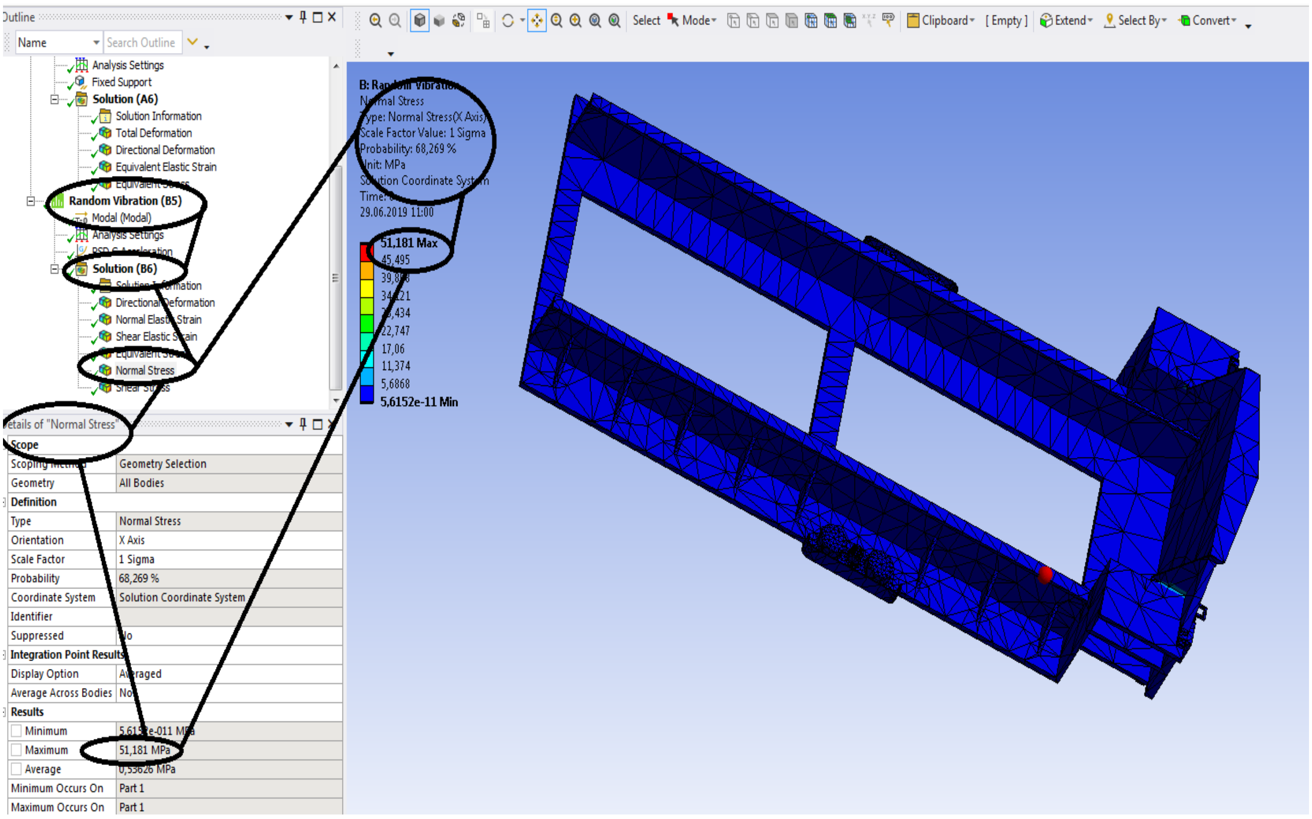


Figura 200 -Tensiuni normale dupa axa OX [MPa]

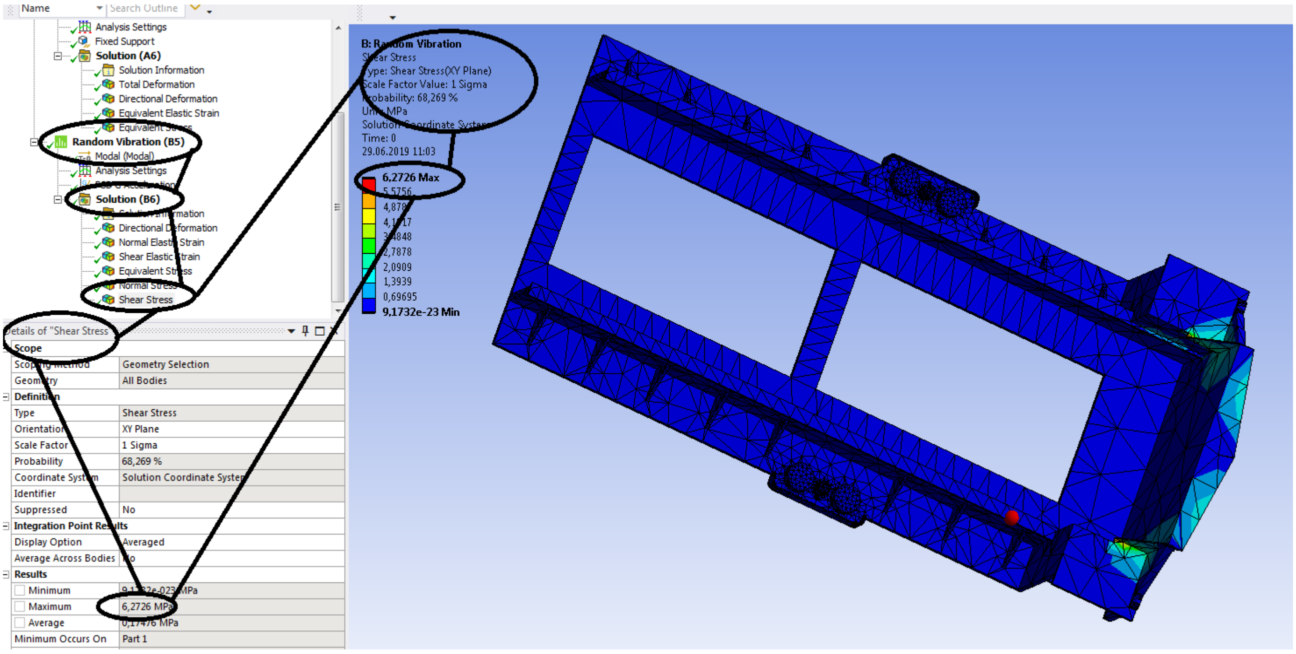


Figura 201 -Tensiuni tangentiale din planul XOY [MPa]

Capitol 3 - Sina de cale ferata

3.1 Static structural mecanic pentru sina de cale ferata

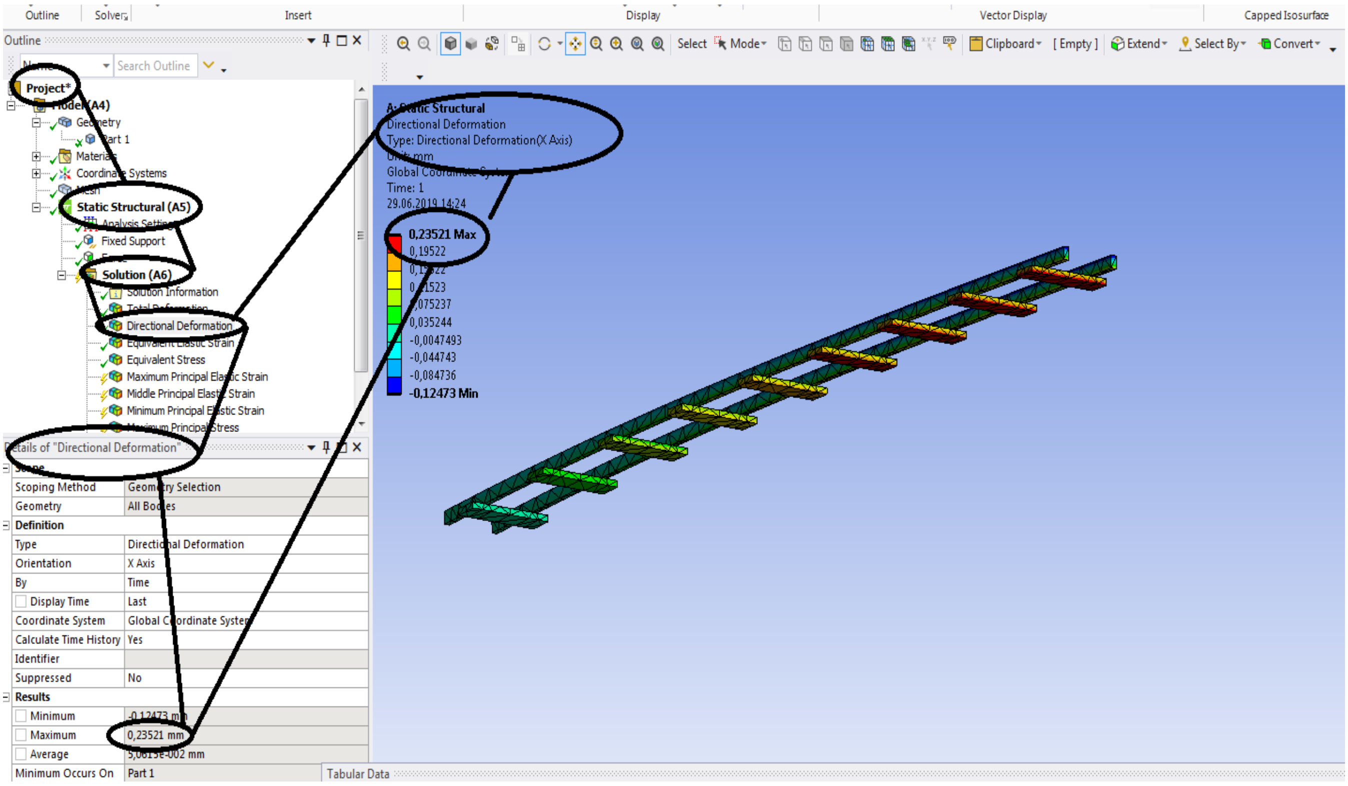


Figura 202 - Deformații upa axa OX [mm]

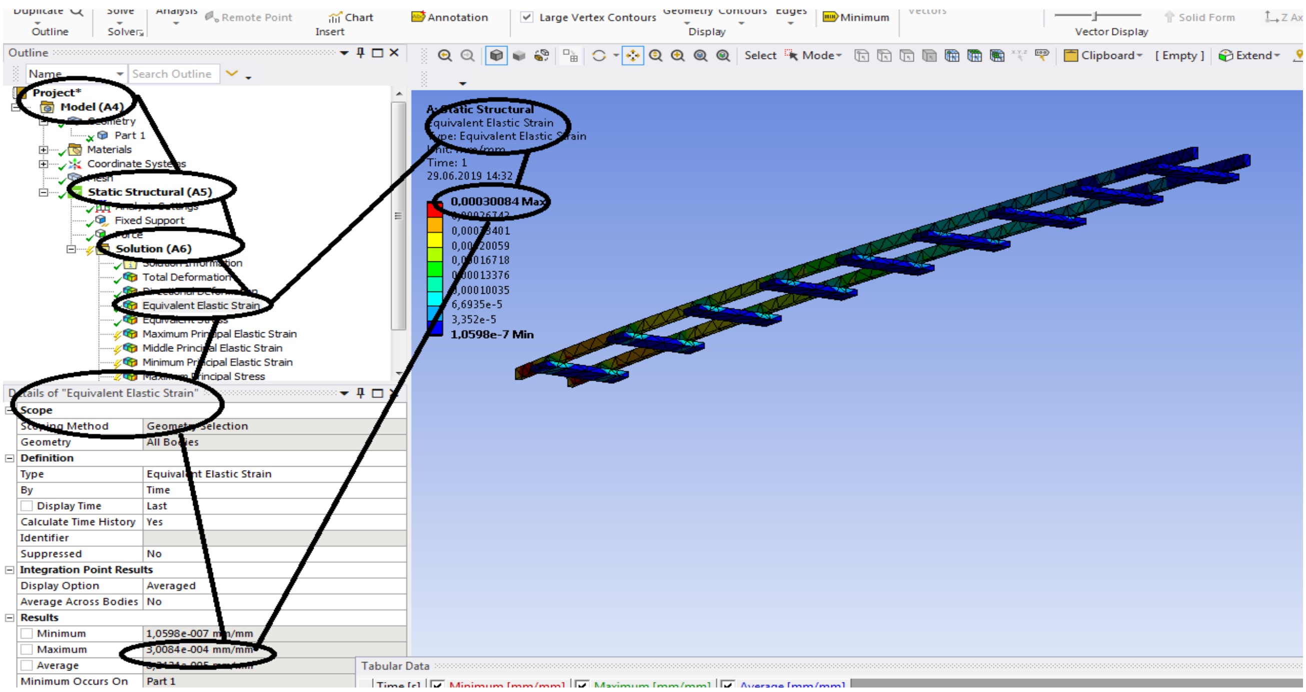


Figura 203 - Deformațiile specifice echivalente ε [mm/mm]

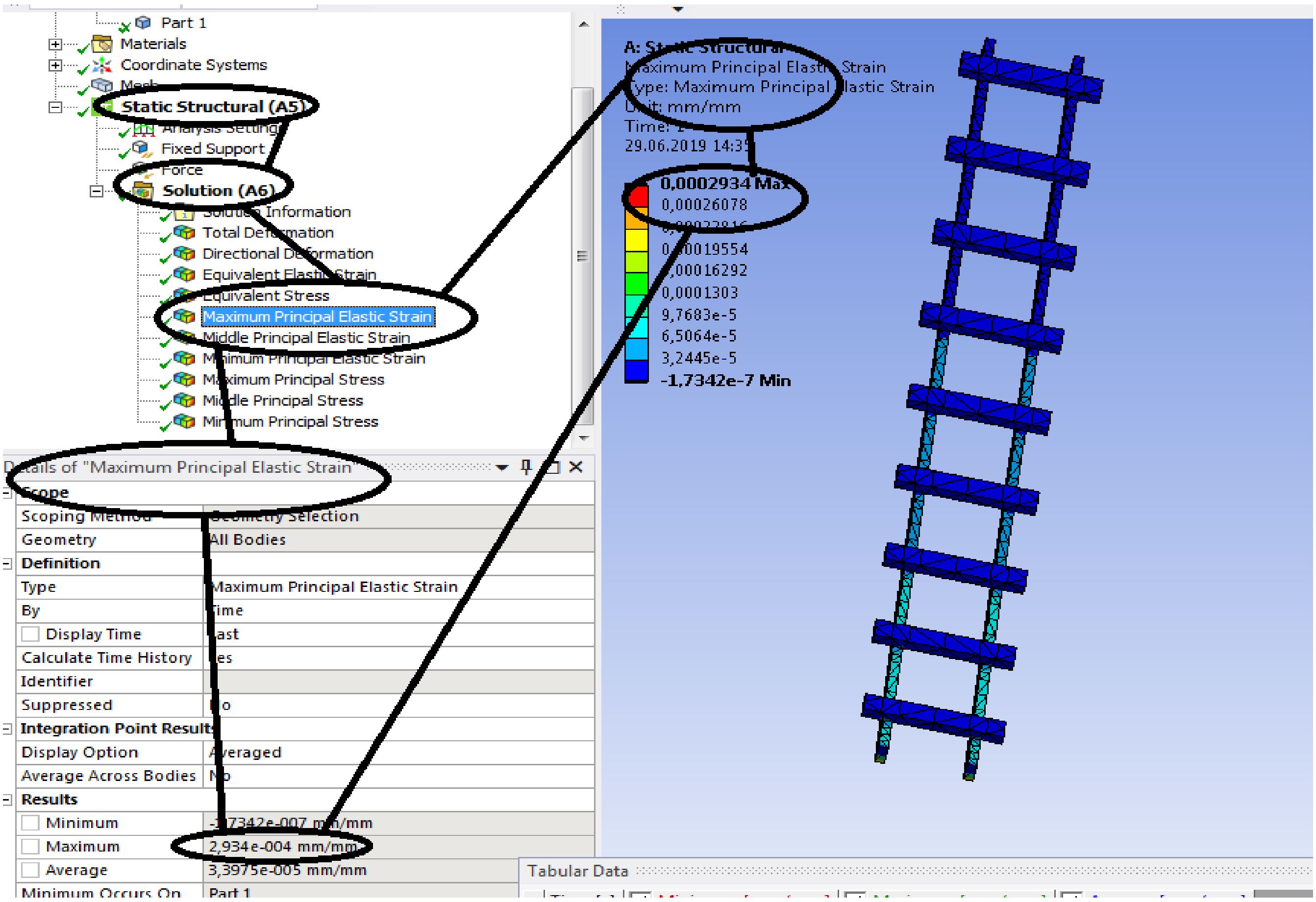


Figura 204 - Deformațiile specifice principale - ε1 [mm/mm]

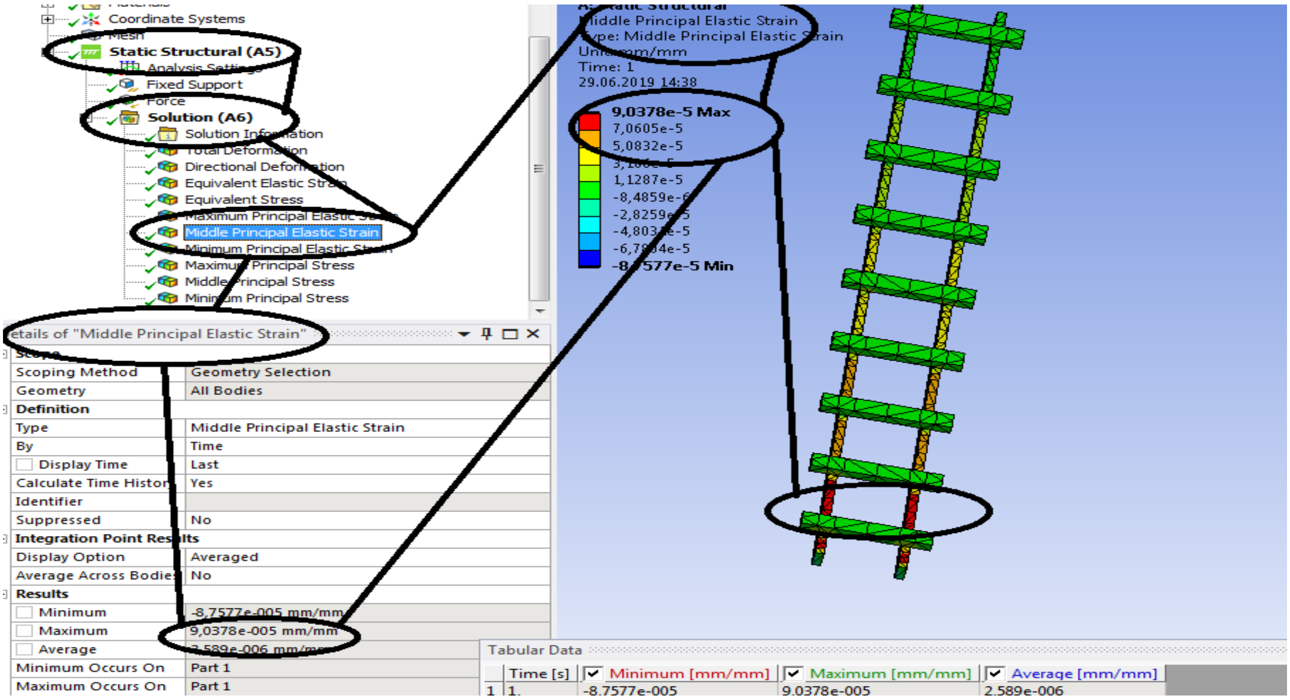


Figura 205 - Deformațiile specifice principale ε2 [mm/mm]

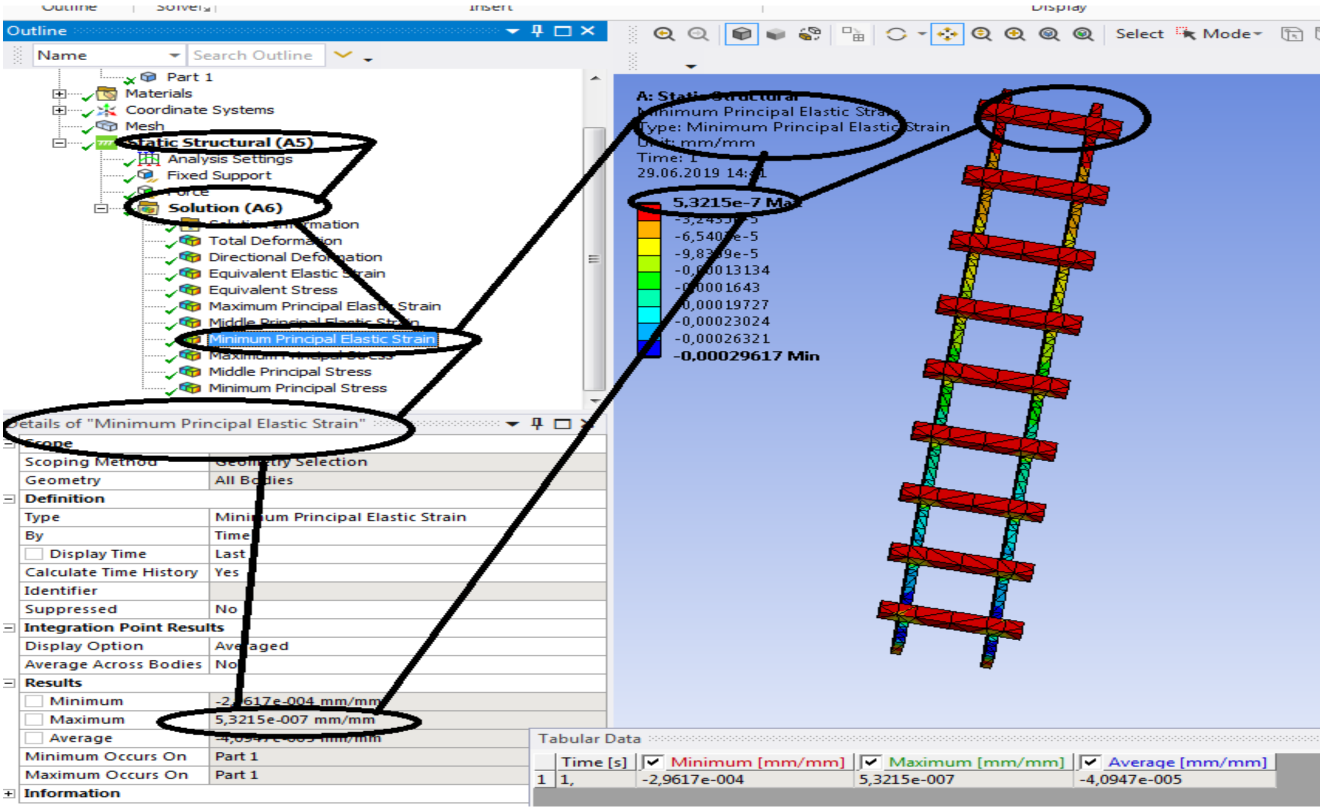


Figura 206 - Deformațiile specifice principale ε3 [mm/mm]

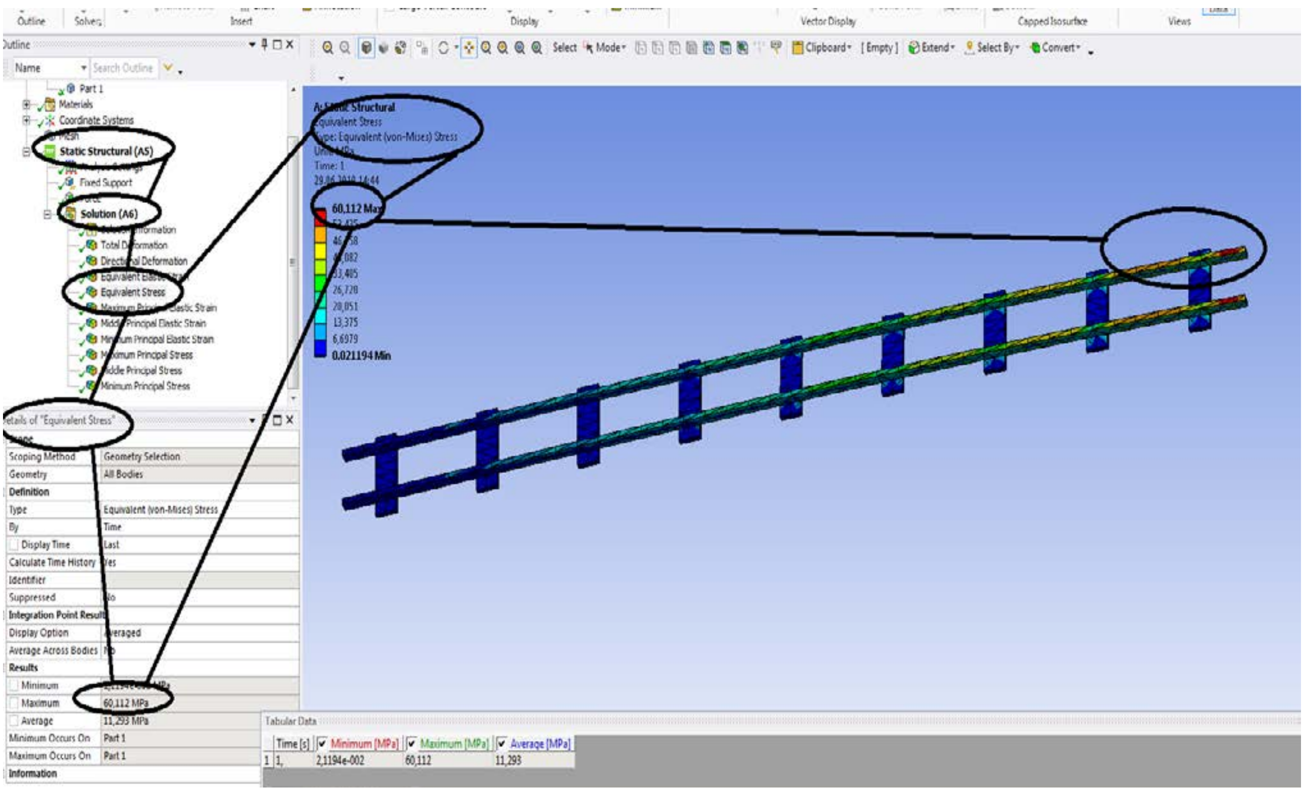


Figura 207- Tensiunile echivalente von Mises [MPa]

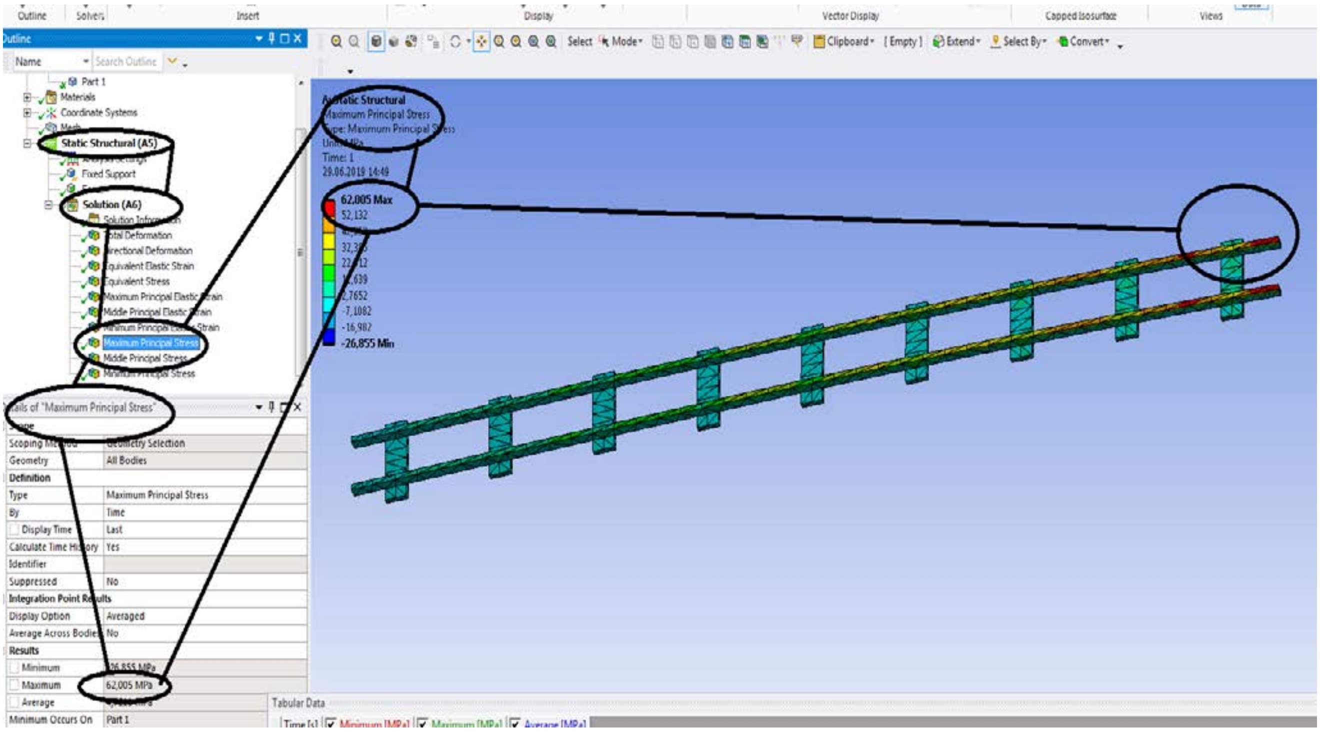


Figura 208 - Tensiunile principale $\sigma 1$ [MPa]

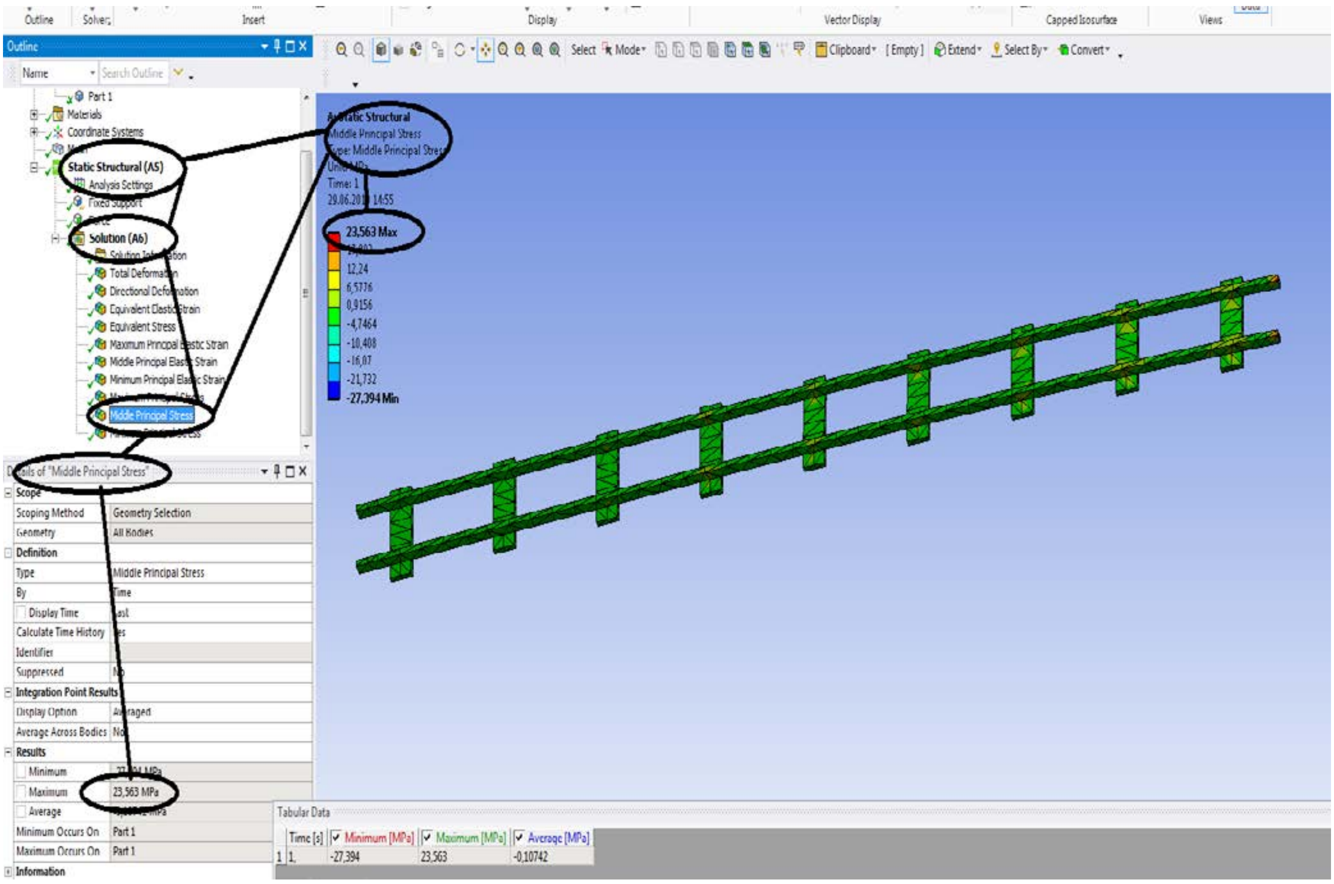


Figura 209 - Tensiunile principale $\sigma 2$ [MPa]

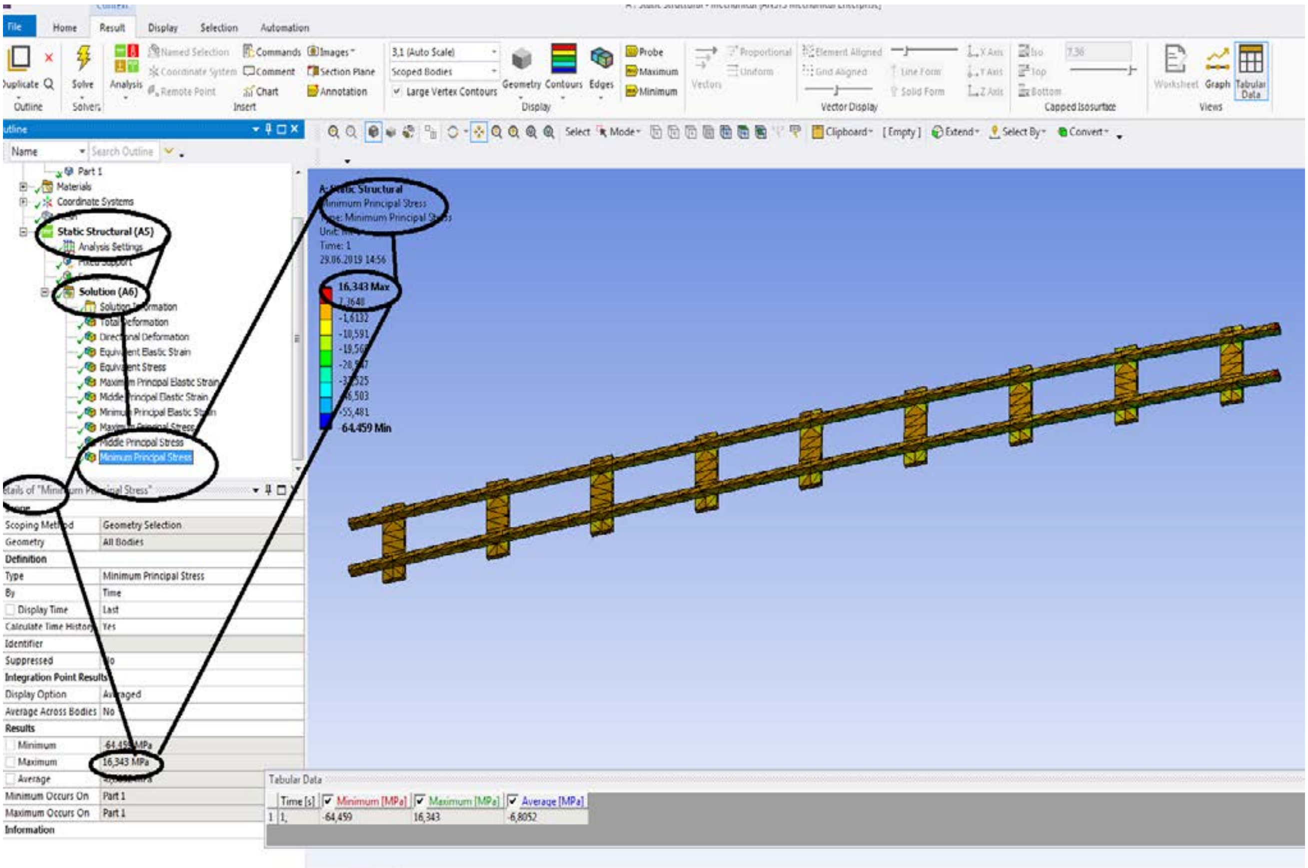


Figura 210 -Tensiunile principale $\sigma 3$ [MPa]

3.2 Static structural termic pentru sina de cale ferata

- Deformații totale [mm];

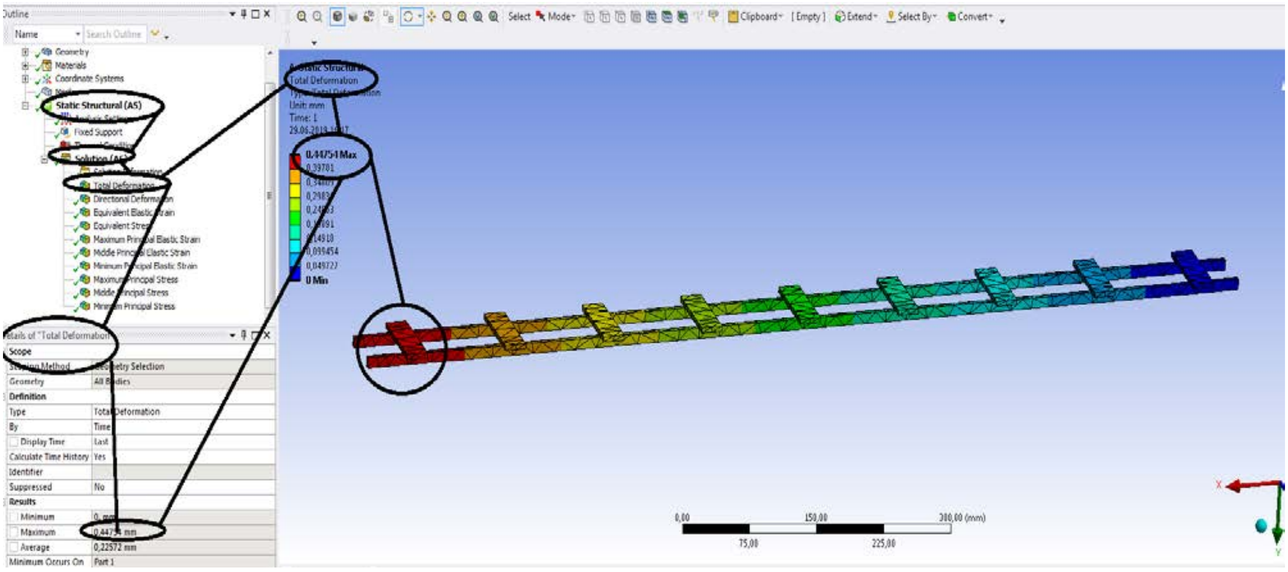


Figura 211 - Deformații totale [mm]

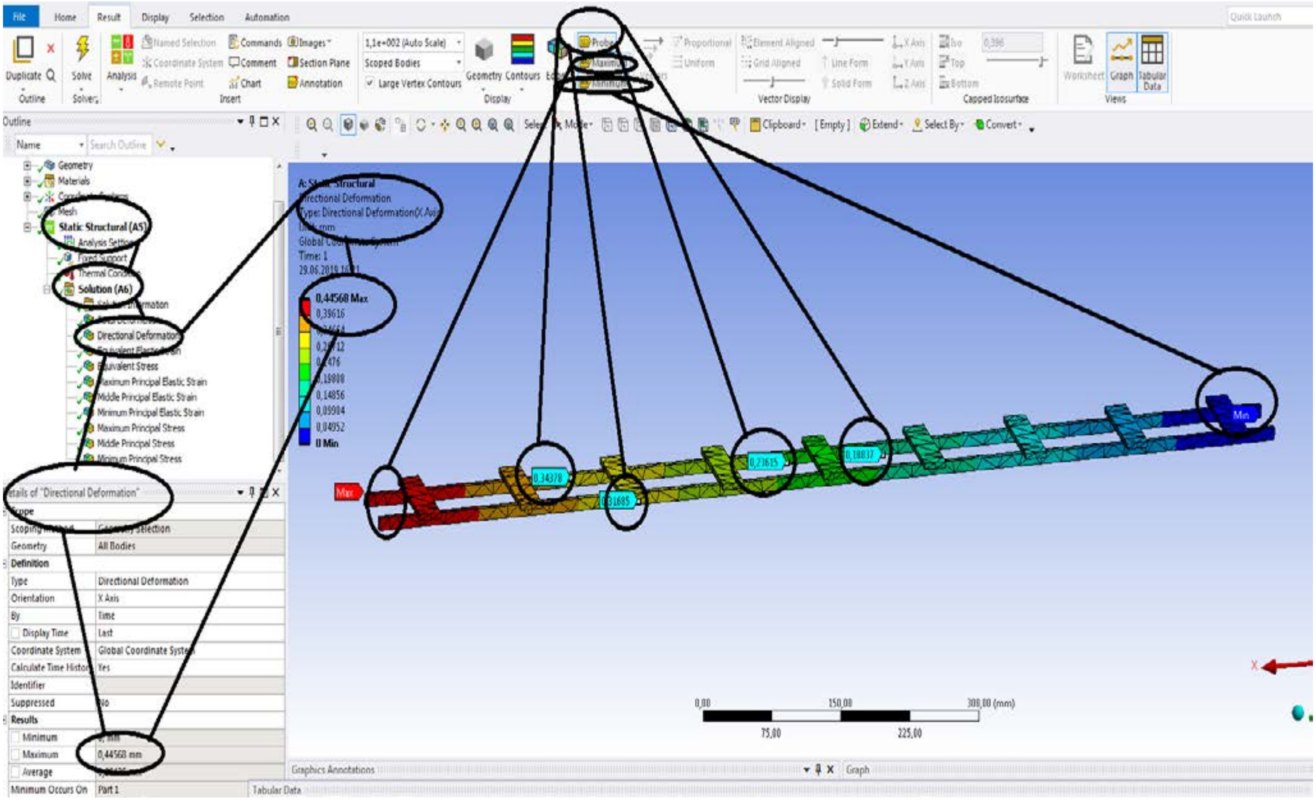


Figura 212 -Deformații direcționale pe axa x [mm]

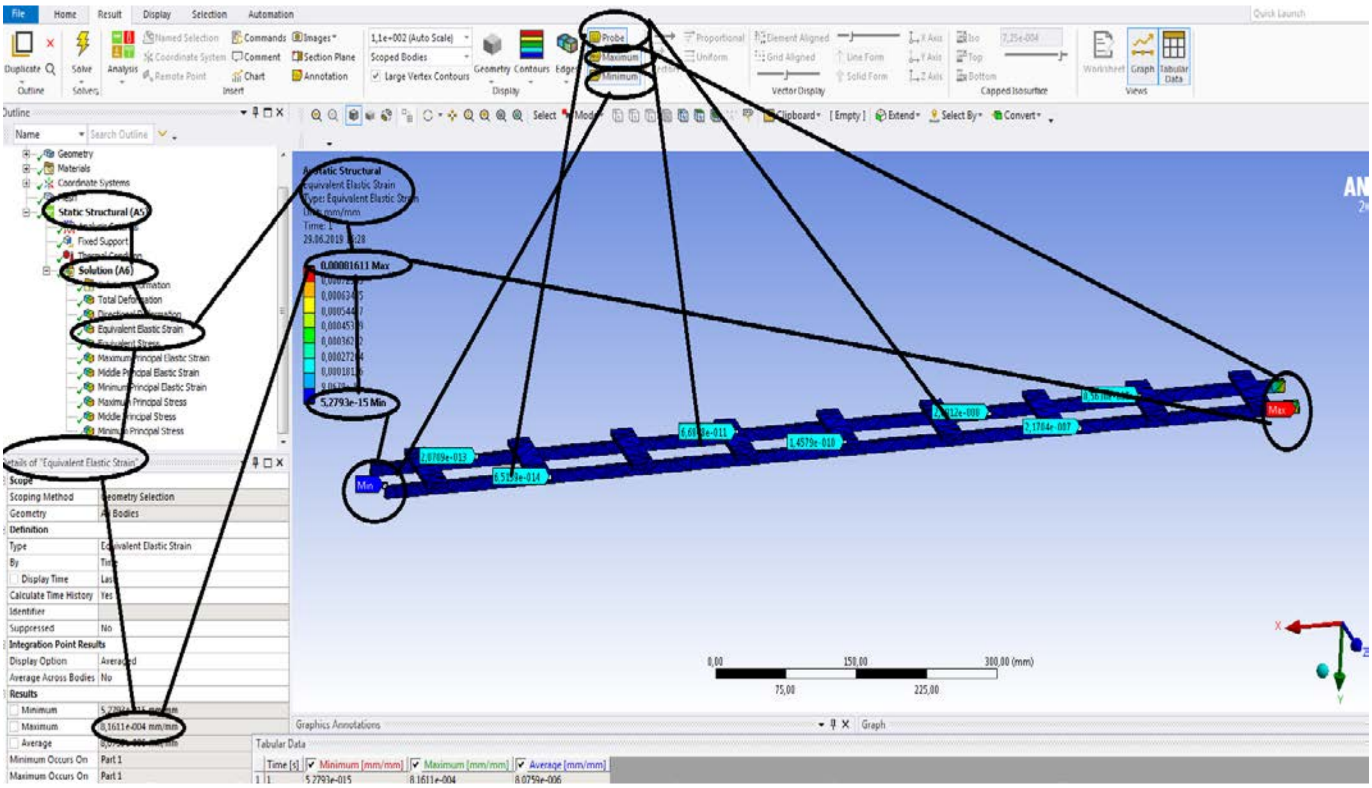


Figura 213 - Deformațiile specifice echivalente ε [mm/mm]

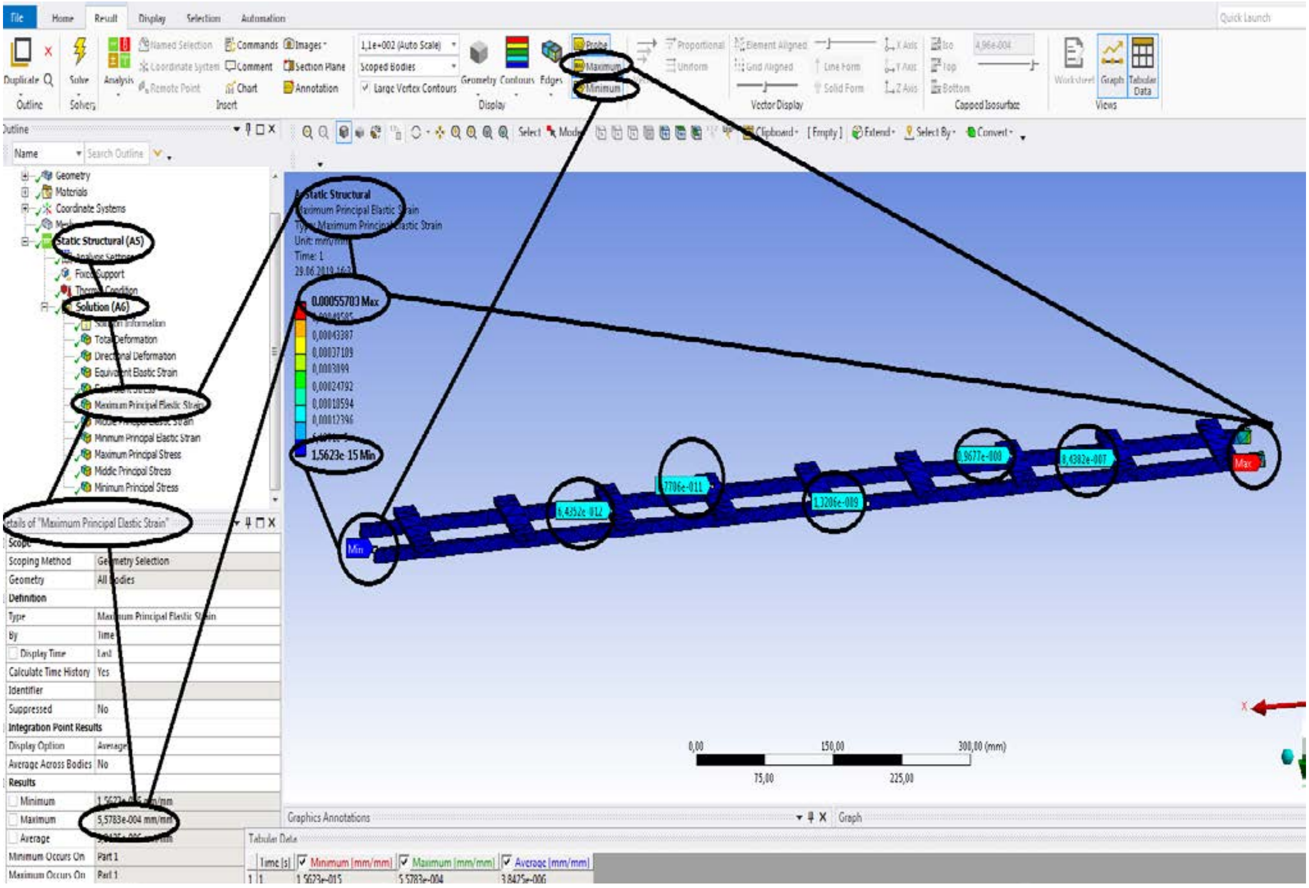


Figura 214 - Deformațiile specifice principale - ε1   [mm/mm]

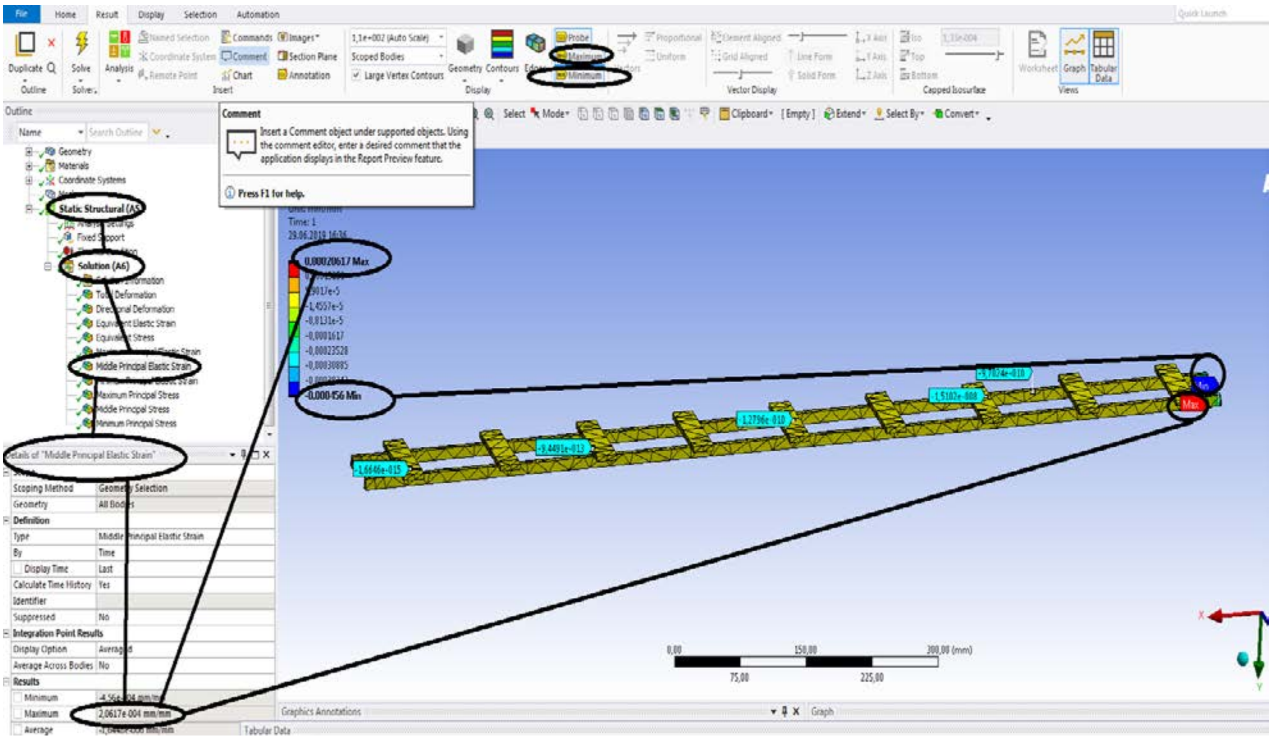


Figura 215 - Deformațiile specifice principale ε2 [mm/mm]

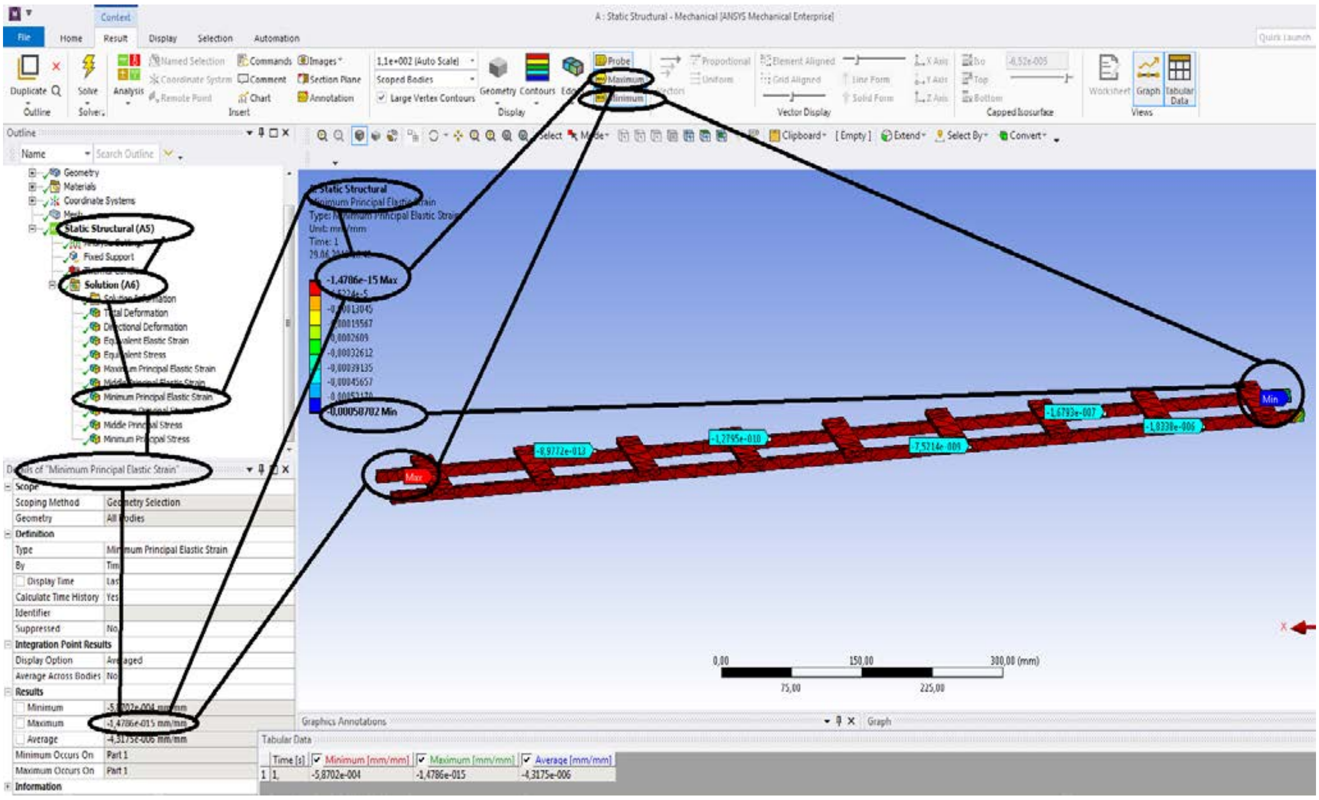


Figura 216 - Deformațiile specifice principale ε3 [mm/mm]

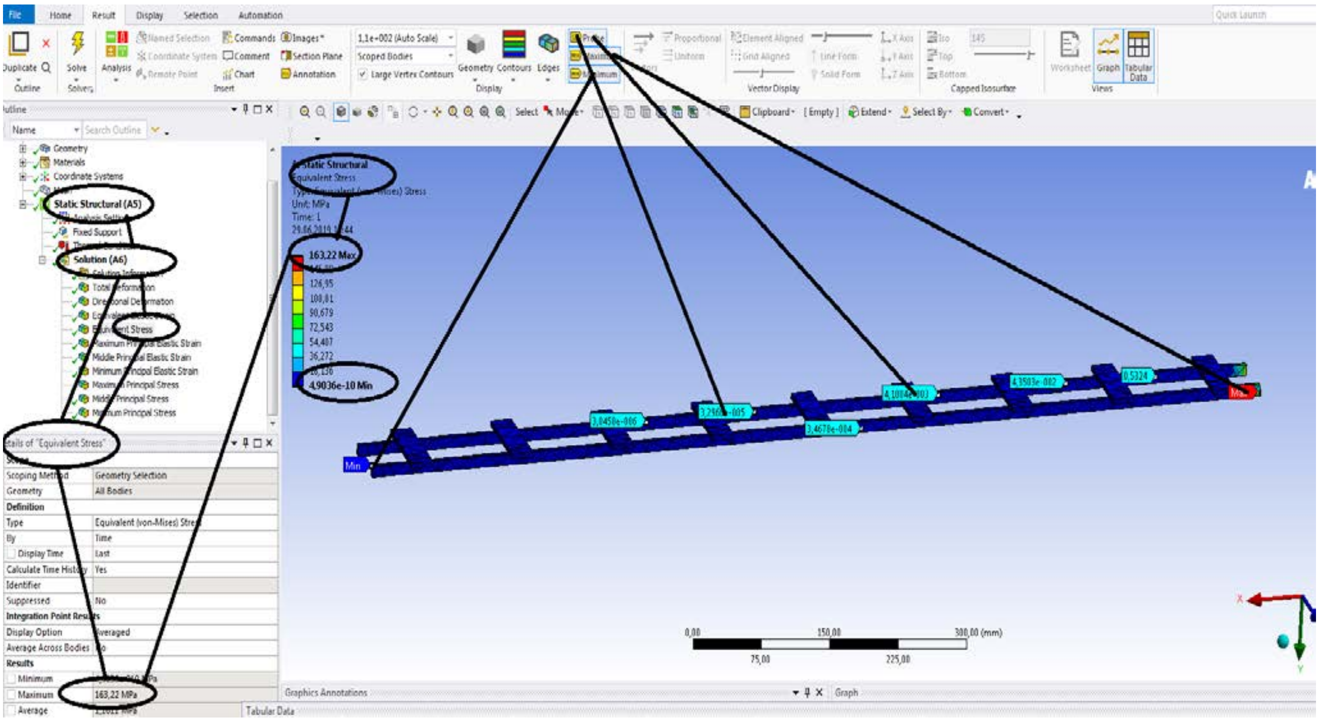


Figura 217- Tensiunile echivalente von Mises [MPa]

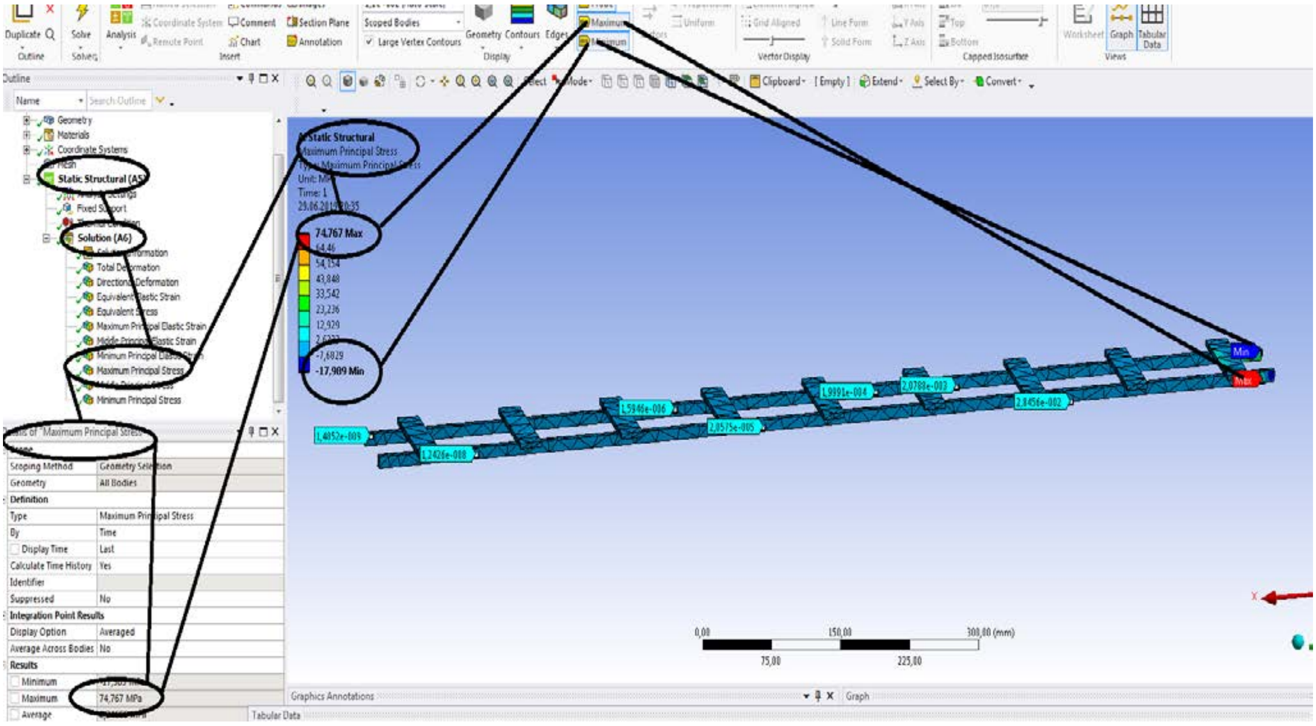


Figura 218 - Tensiunile principale $\sigma 1$ [MPa]

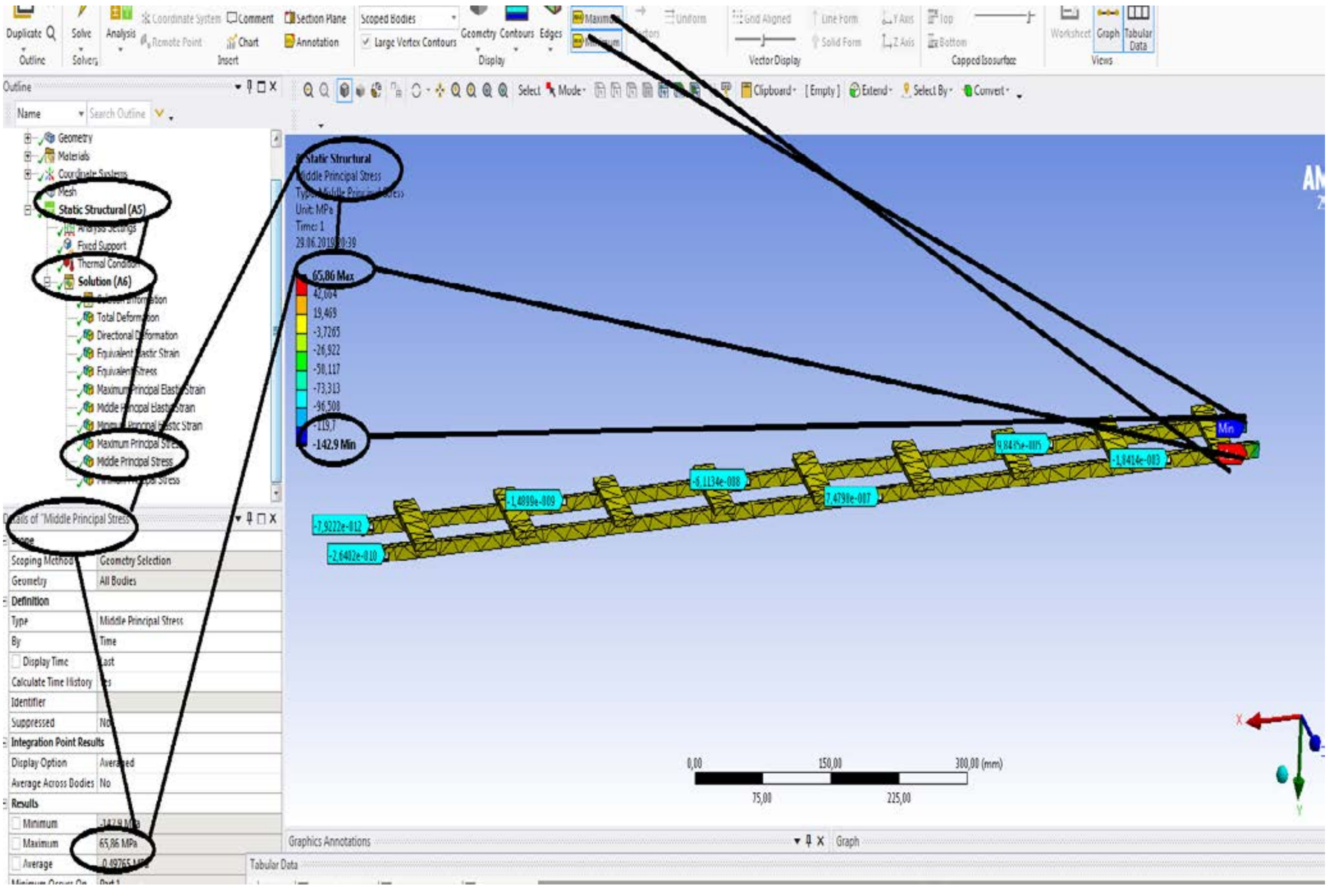


Figura 219- Tensiunile principale $\sigma 2$ [MPa]

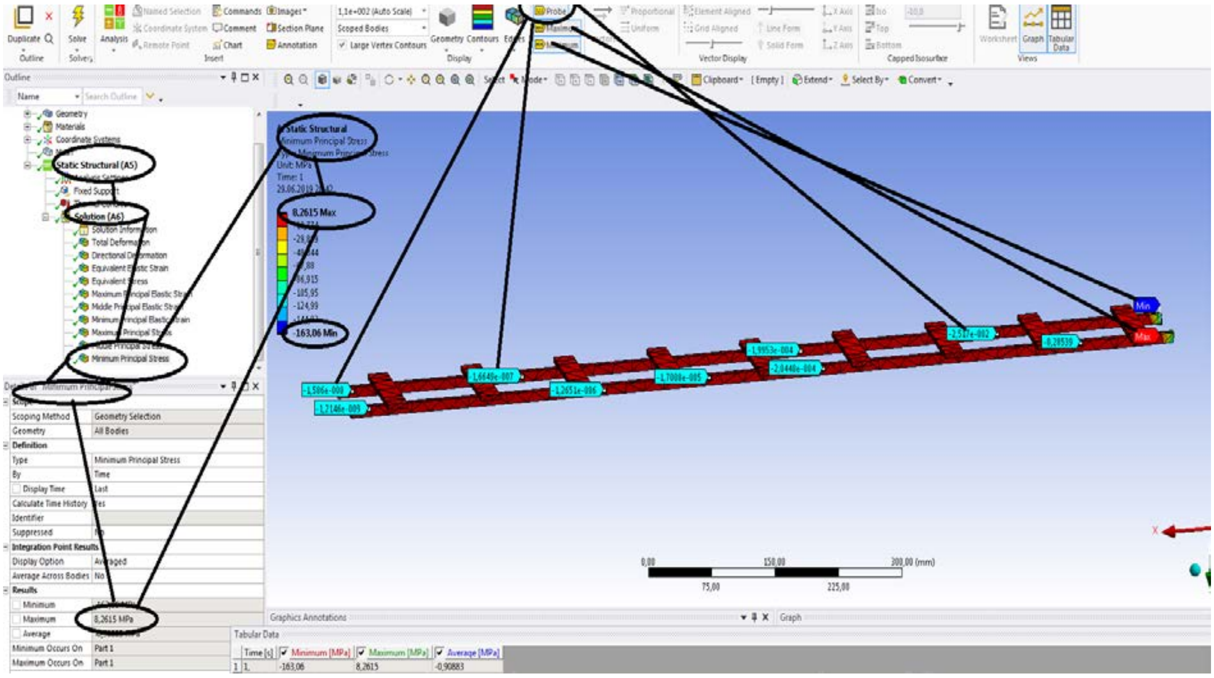


Figura 220 -Tensiunile principale $\sigma 3$ [MPa]

3.3 Static structural mecanic si termic pentru sina de cale ferata

Rezultate

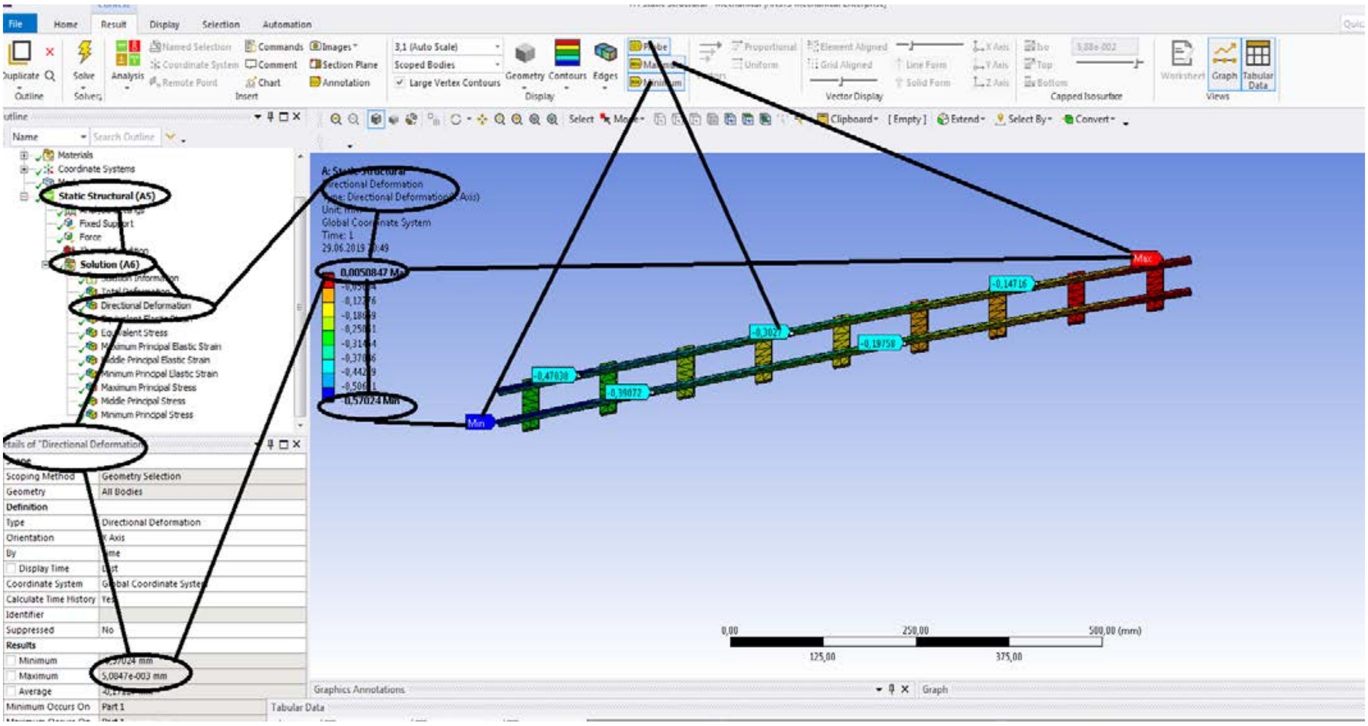


Figura 221 -Deformații direcționale pe axa x [mm]

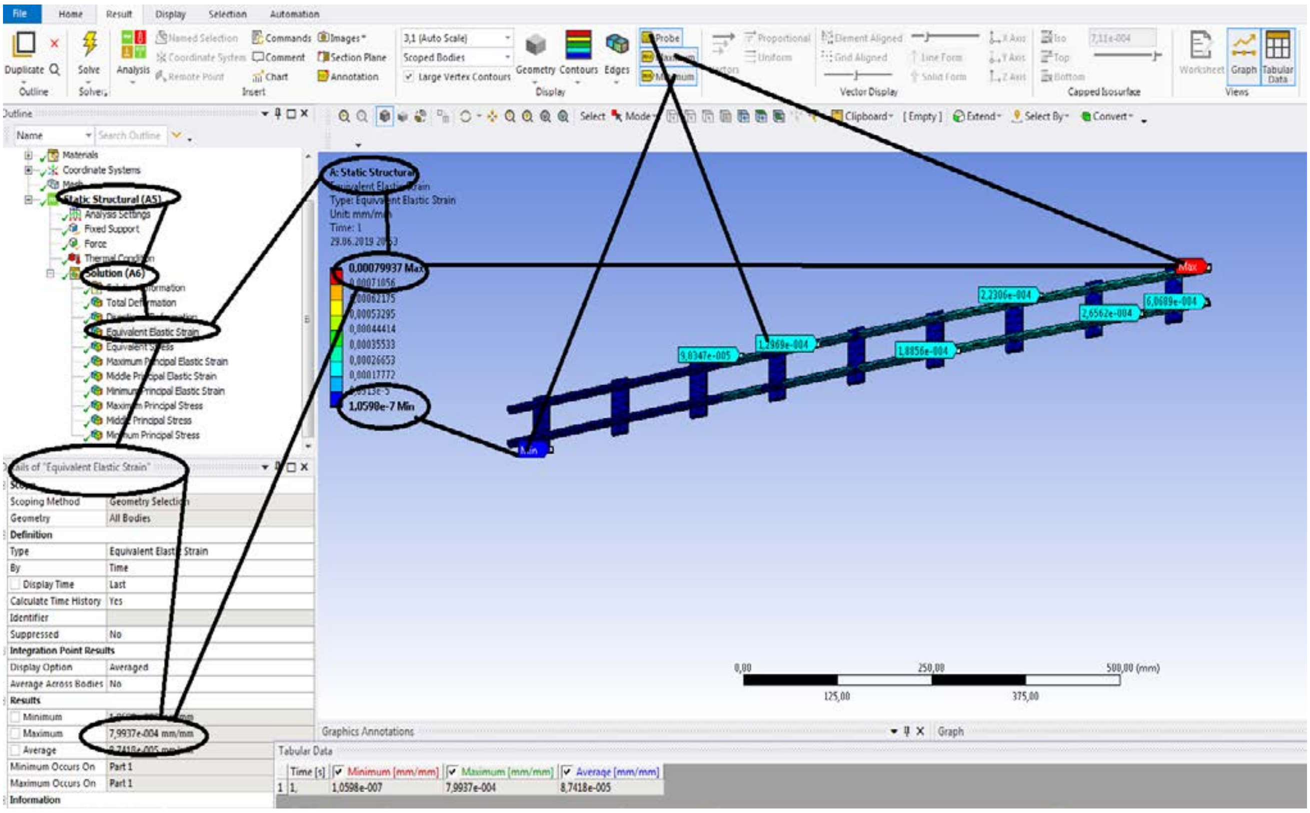


Figura 222 - Deformațiile specifice echivalente ε [mm/mm]

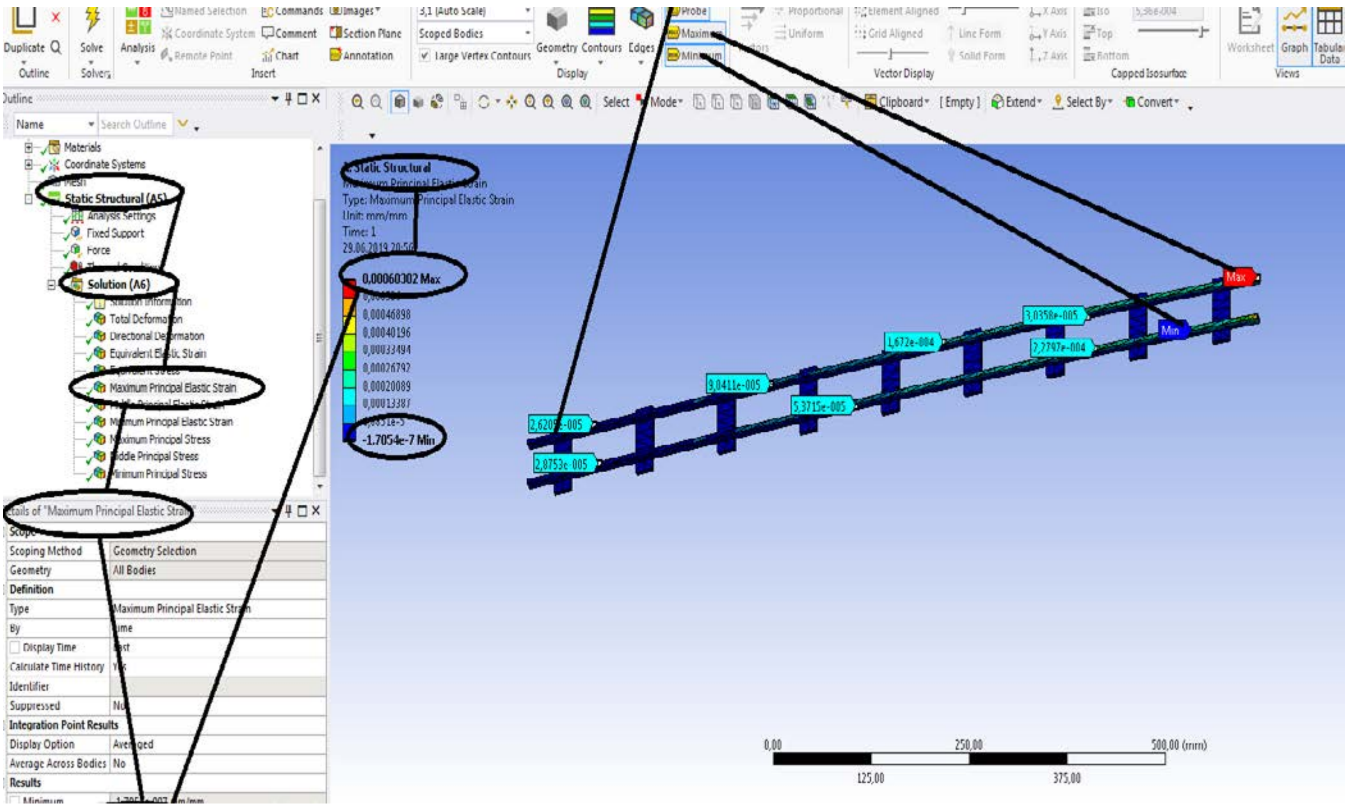


Figura 223 - Deformațiile specifice principale - ε1 [mm/mm]

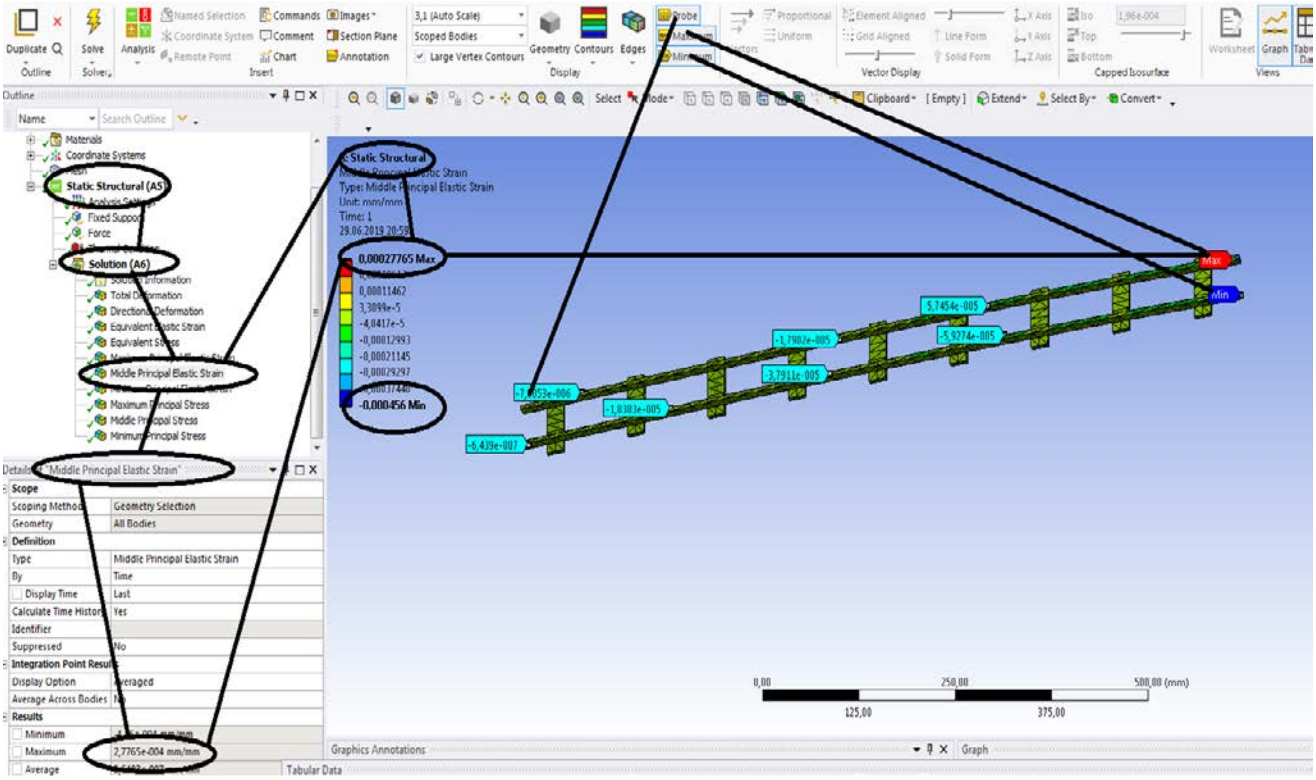


Figura 224 - Deformațiile specifice principale ε2 [mm/mm]

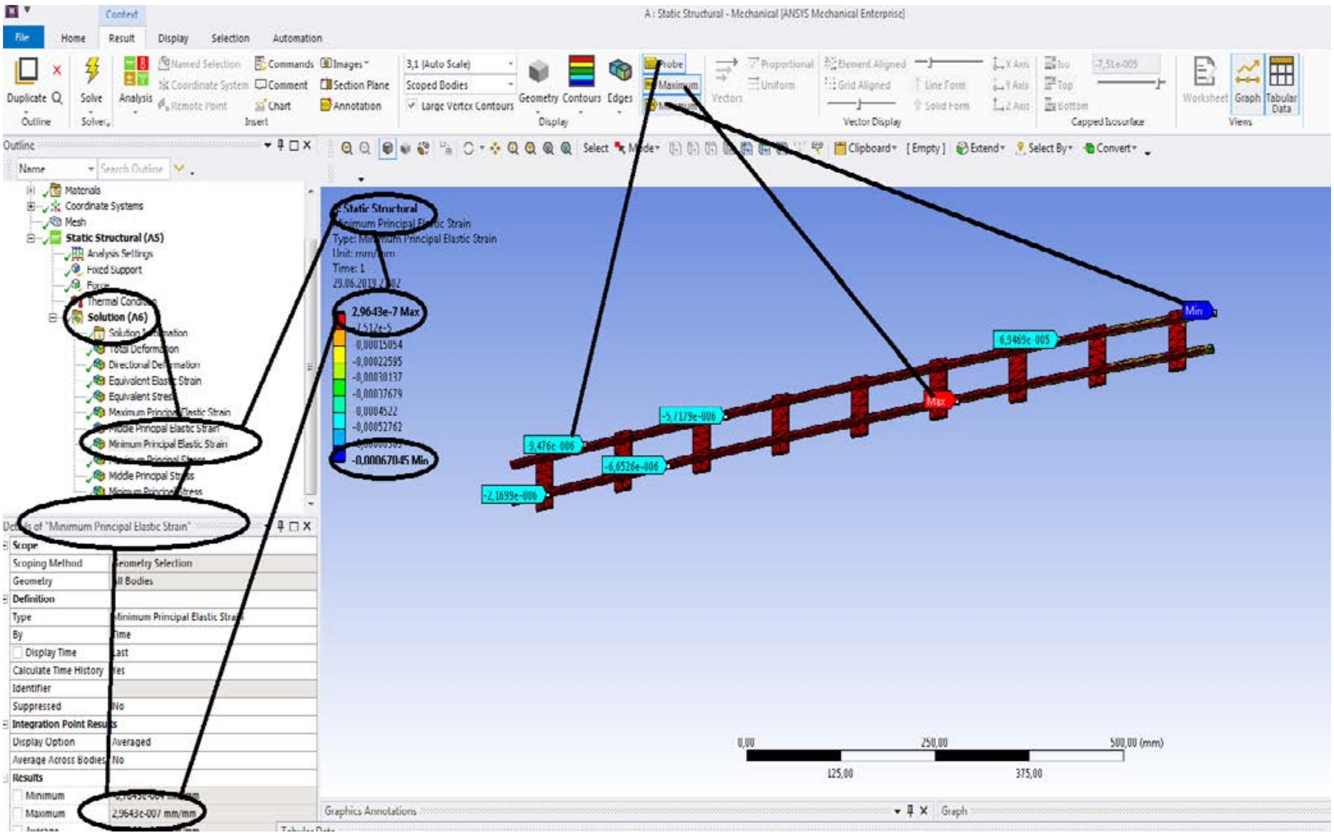


Figura 225 - Deformațiile specifice principale ε3 [mm/mm]

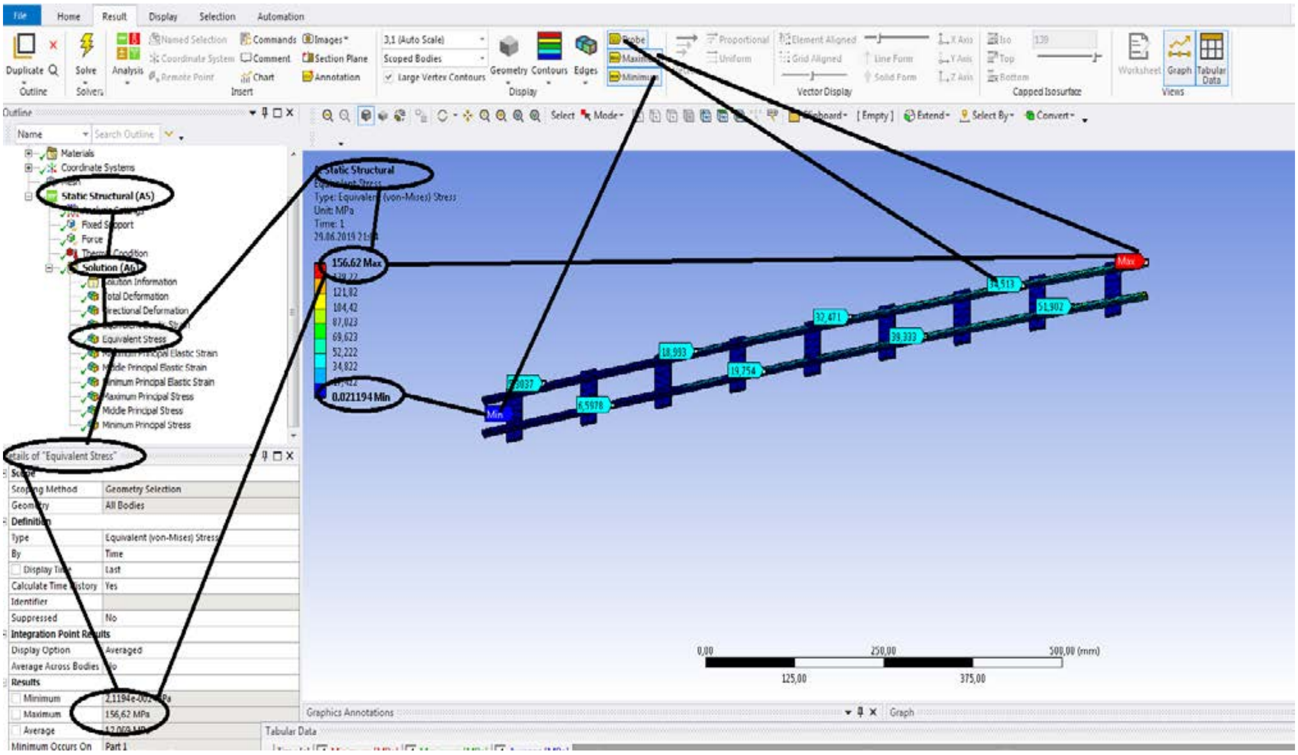


Figura 226 - Tensiunile echivalente von Mises [MPa]

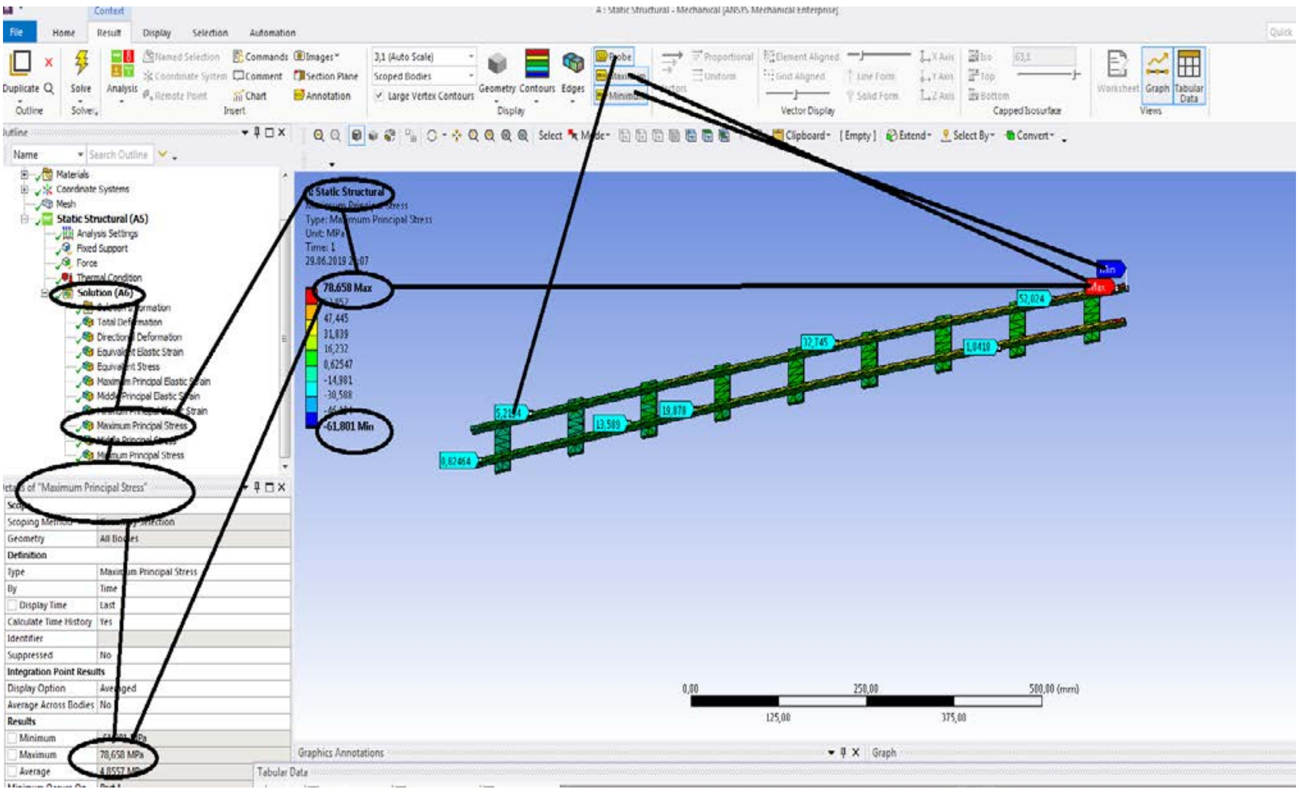


Figura 227 - Tensiunile principale $\sigma 1$ [MPa]

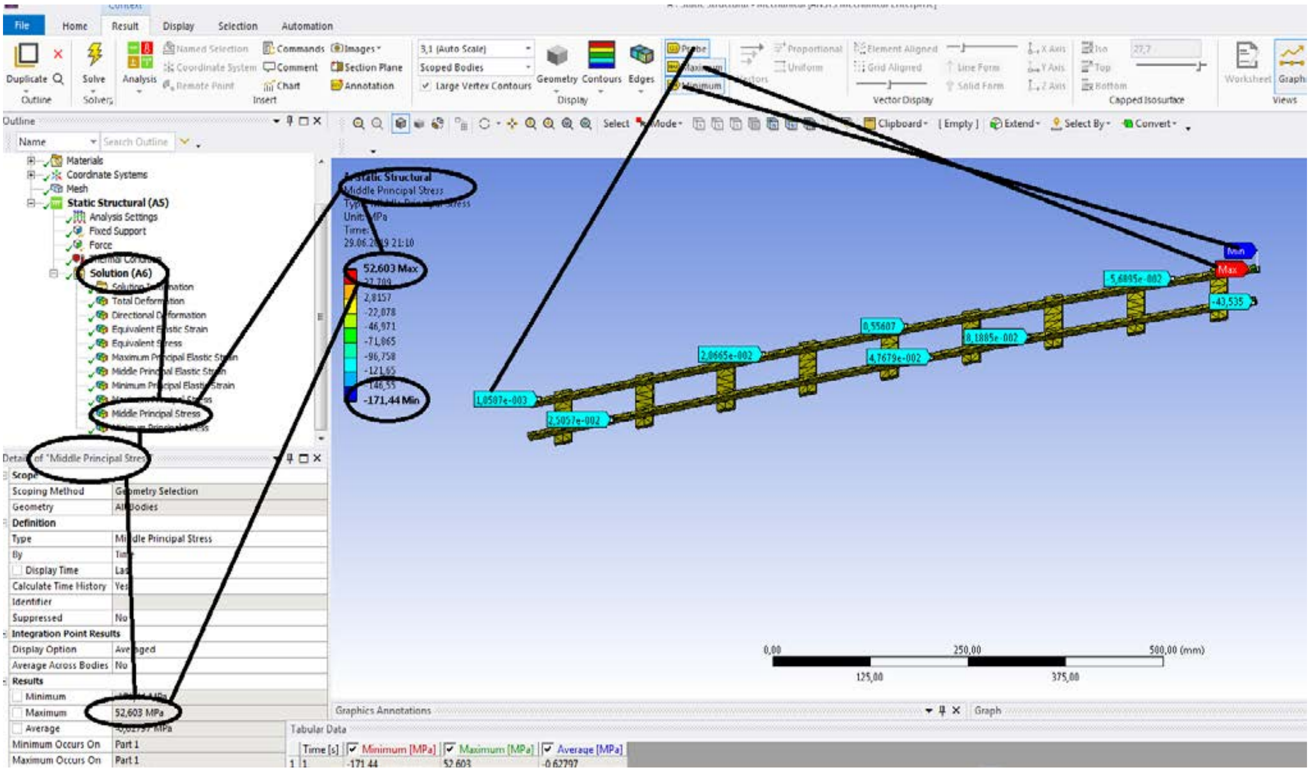


Figura 228 - Tensiunile principale $\sigma 2$ [MPa]

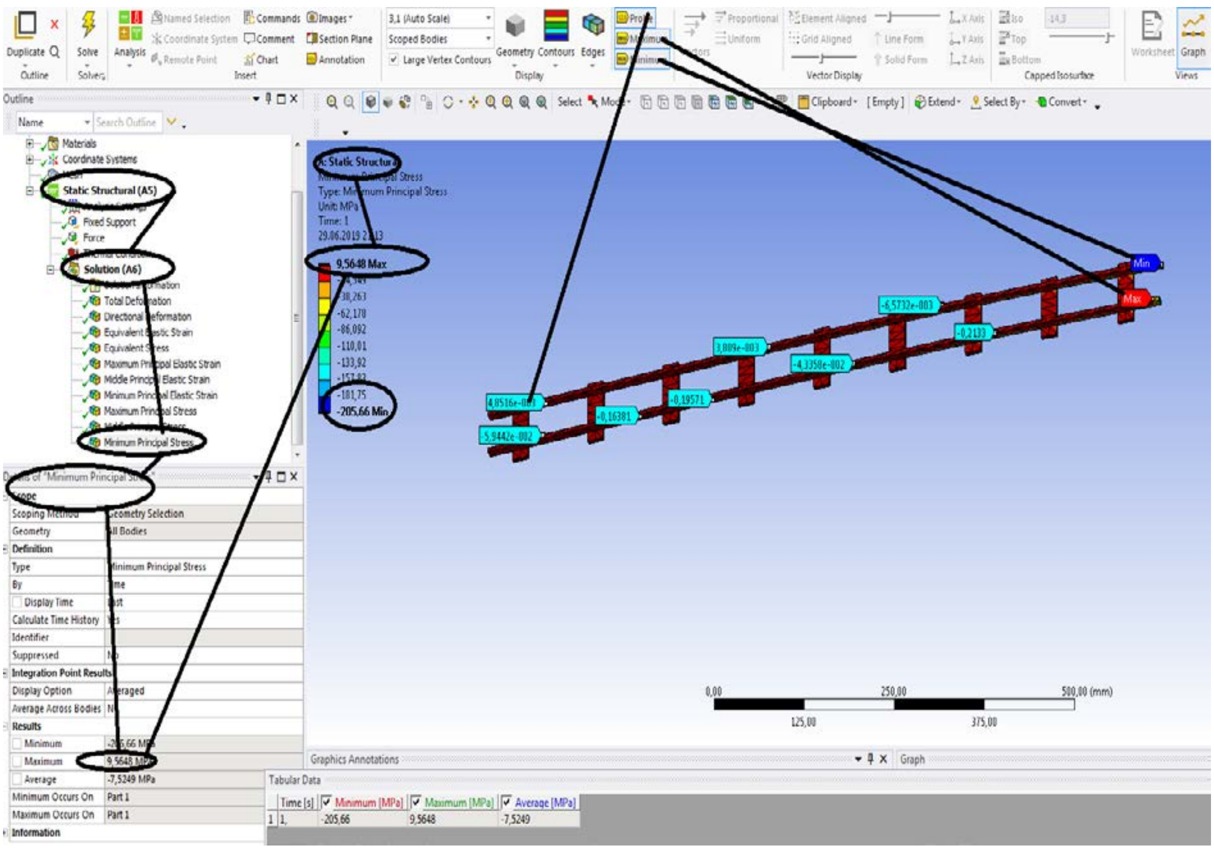


Figura 229 -Tensiunile principale $\sigma 3$ [MPa

3.4 Solicitarea la oboseala pentru sina de cale ferata

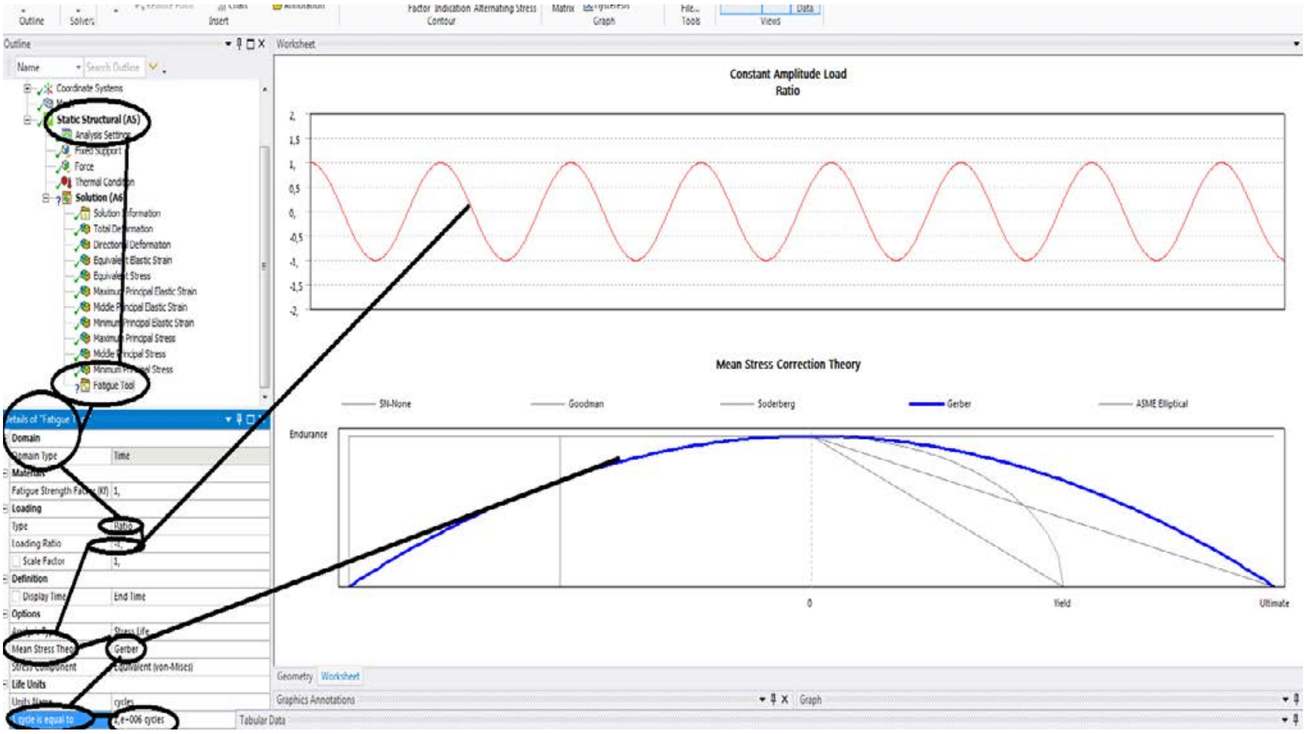


Figura 230 – Solicitarea la oboseala - Selectare

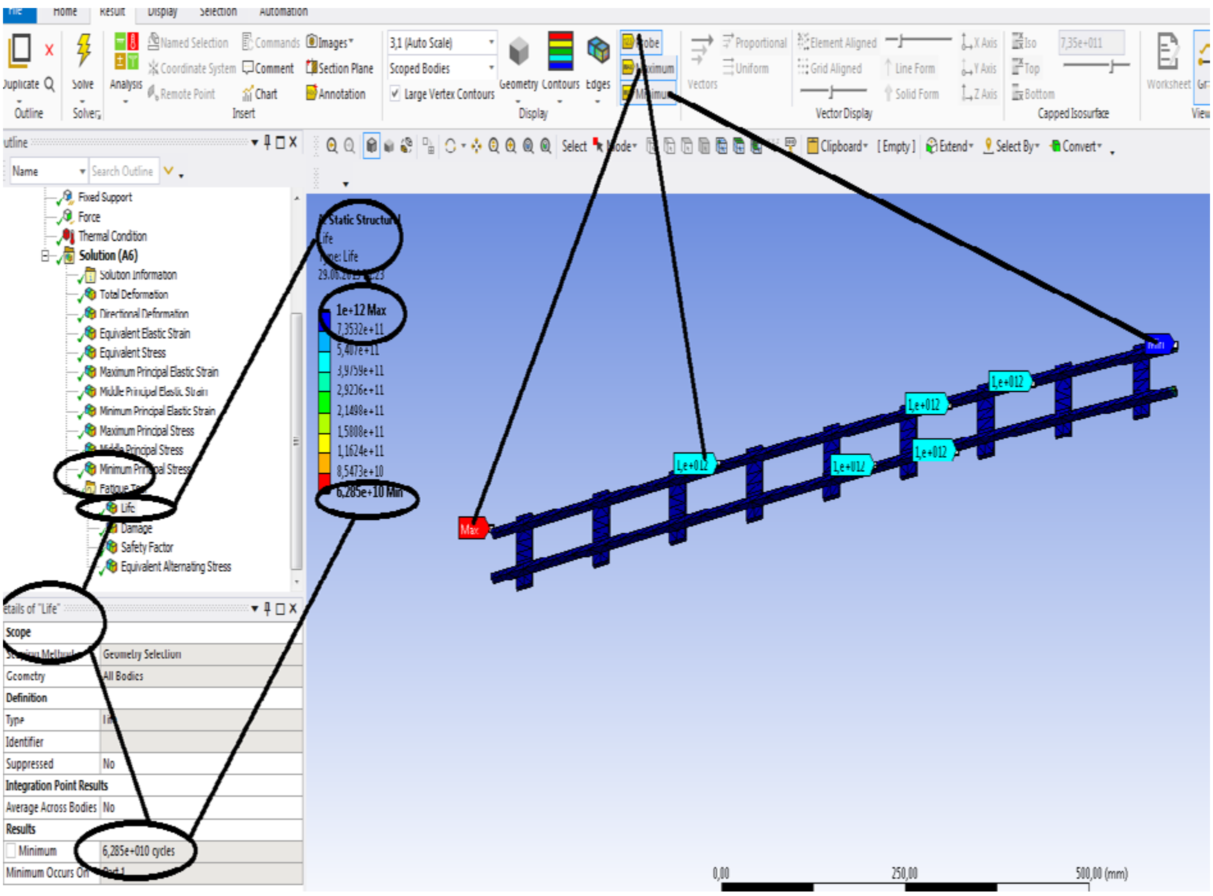


Figura 231 -Durata de viata [s]

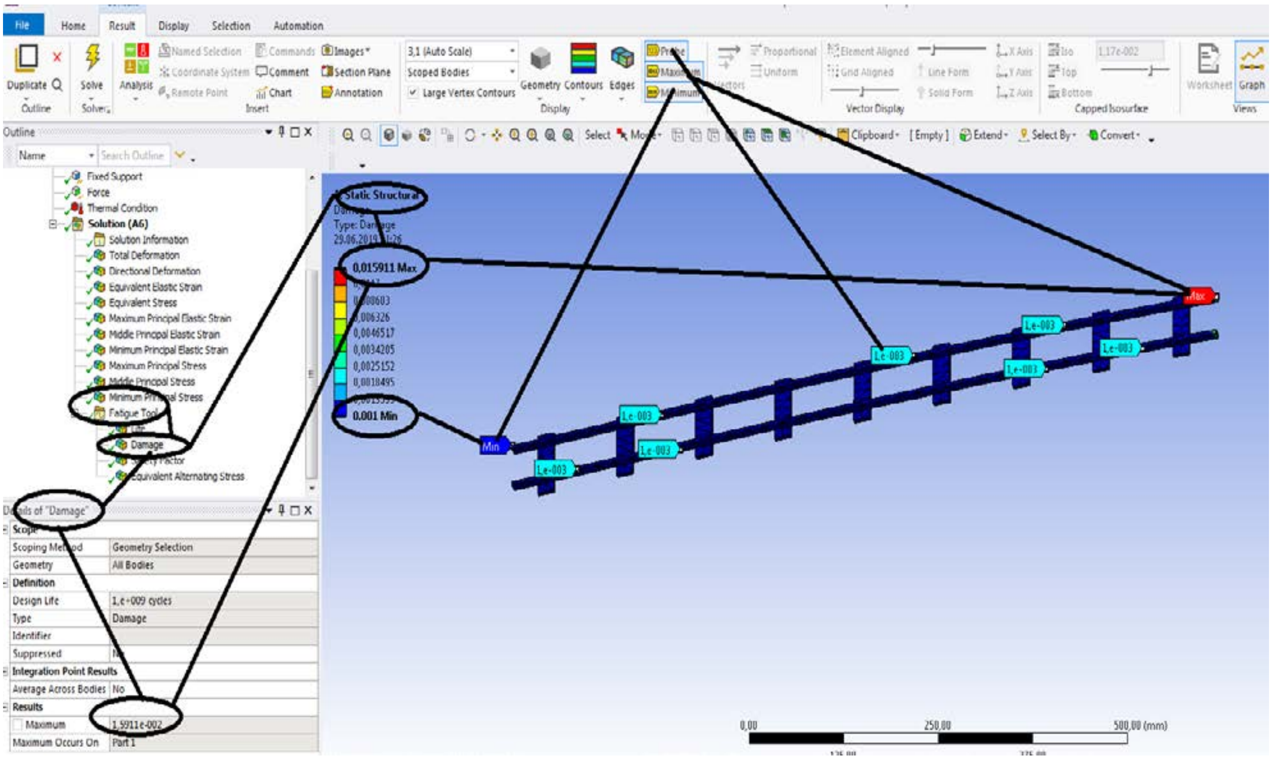


Figura 232 - Avarii [s]

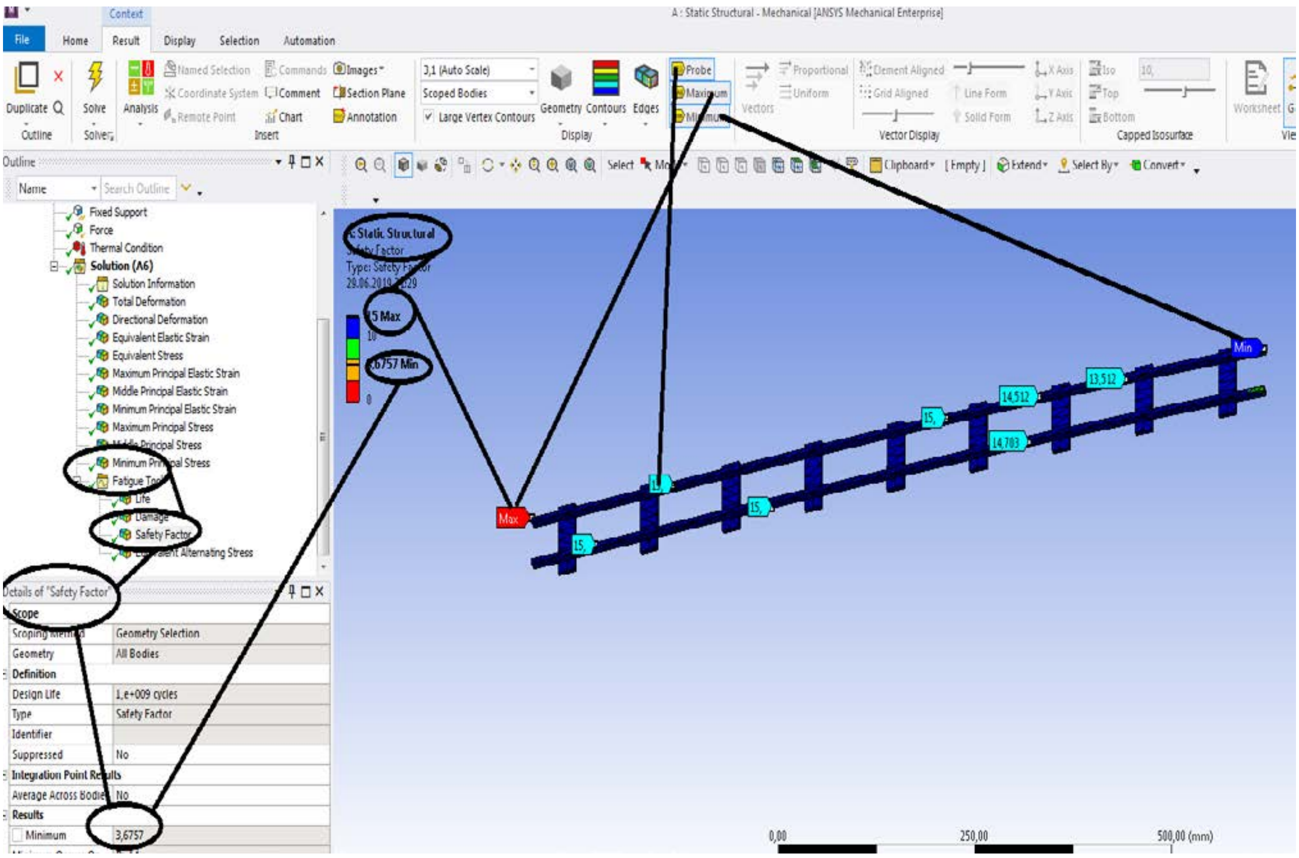


Figura 233 - Coeficientii de siguranta

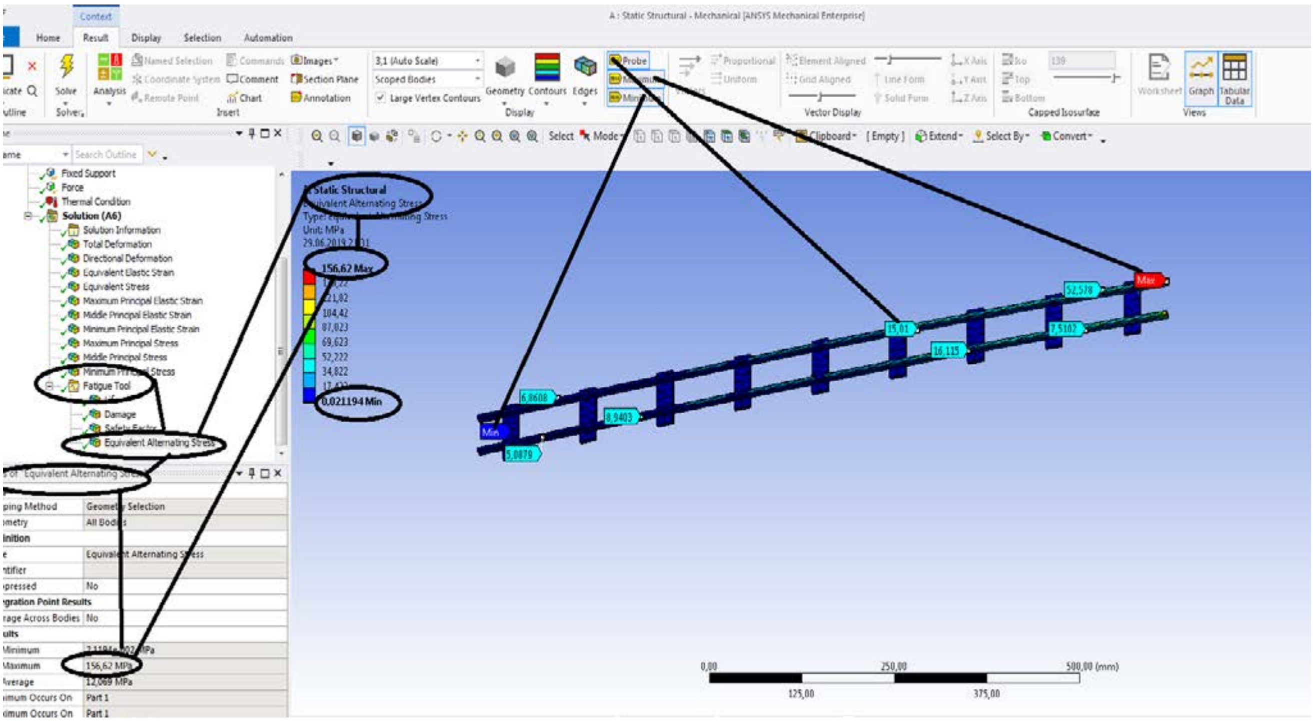


Figura 234- Tensiunea la oboseala [MPa]

Capitol 4 – Vagon cale ferata

4.1 Static structural mecanic pentru vagon cale ferata

-Rezultate

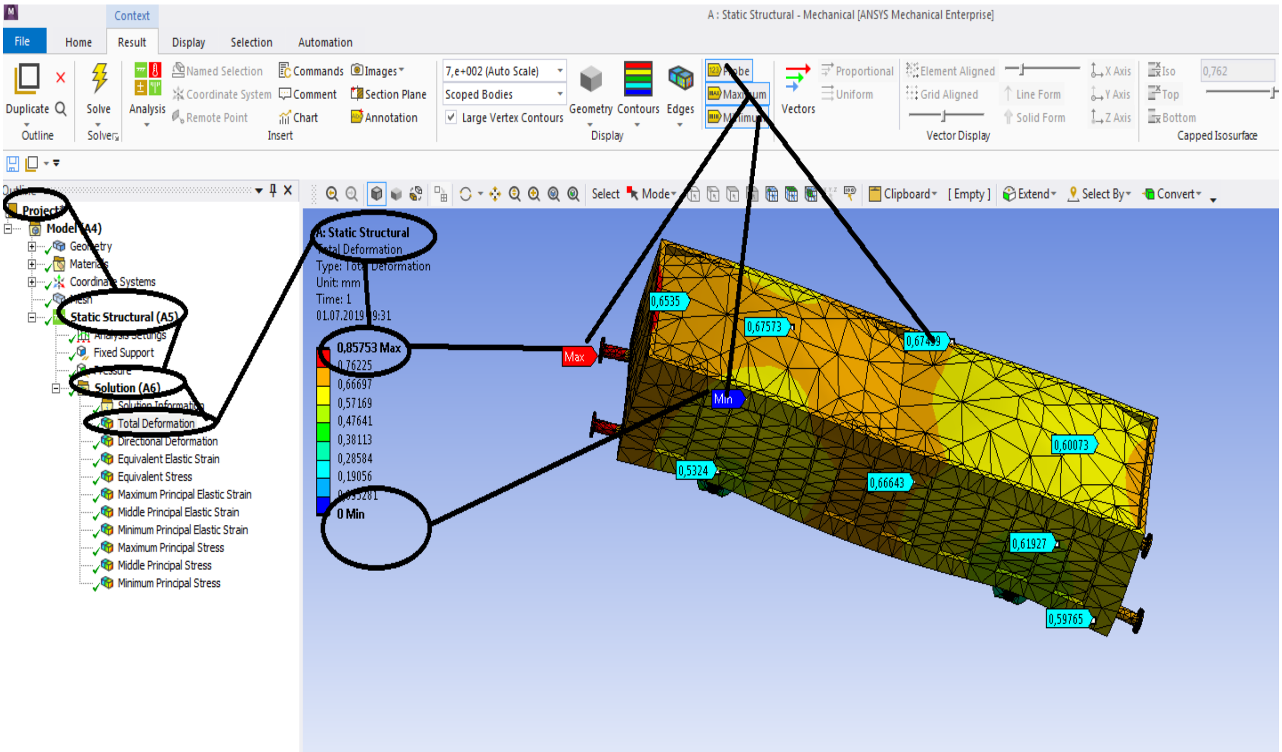


Figura 235 - Deformații totale [mm]

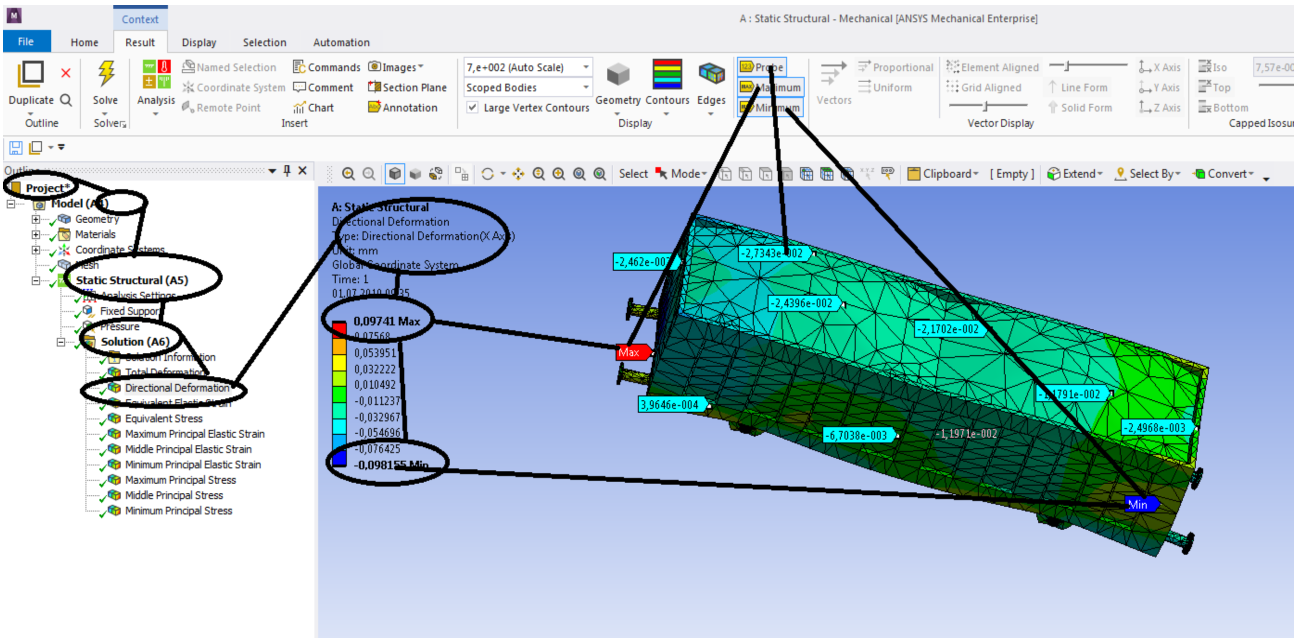


Figura 236 -Deformații direcționale pe axa x [mm]

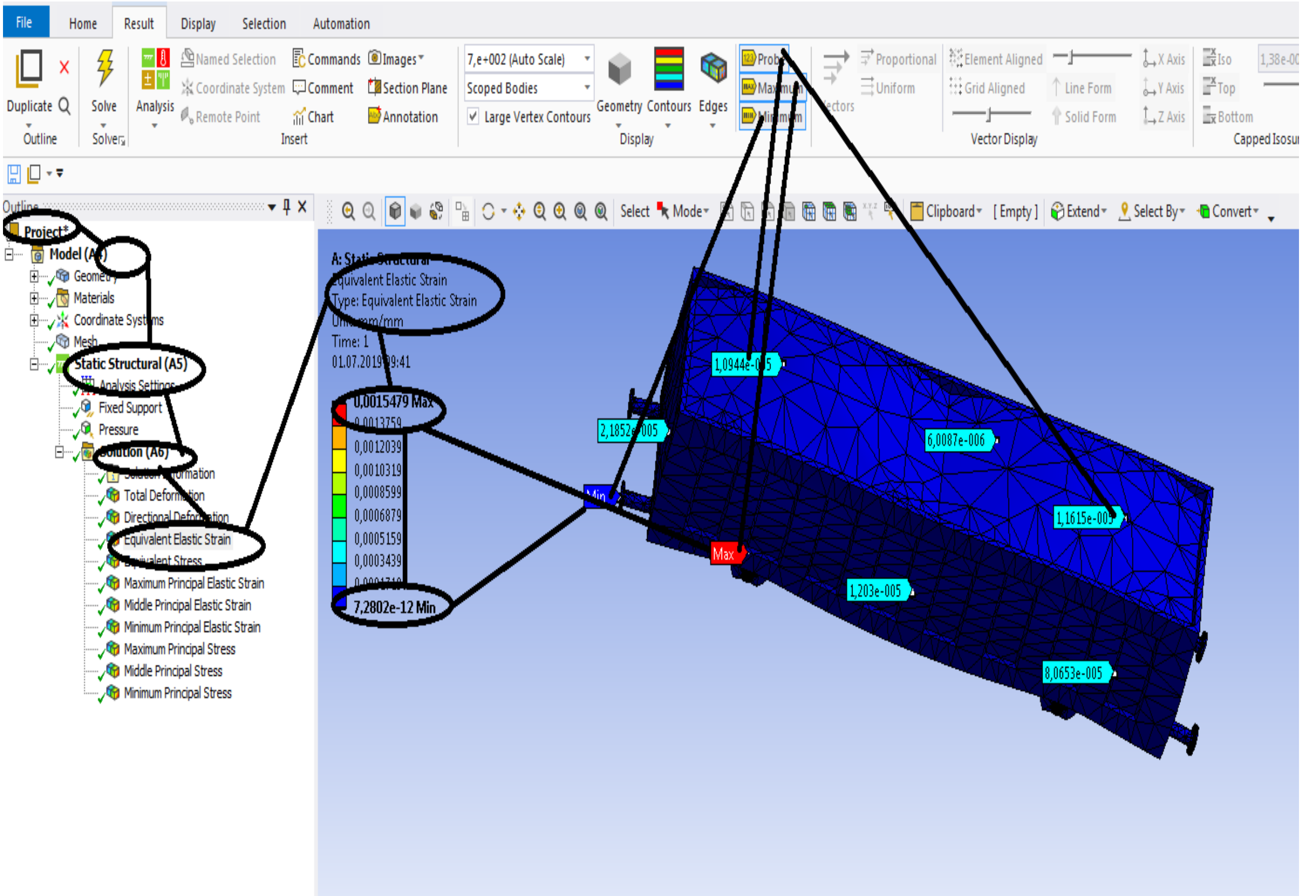


Figura 237 - Deformațiile specifice echivalente ε[mm/mm]

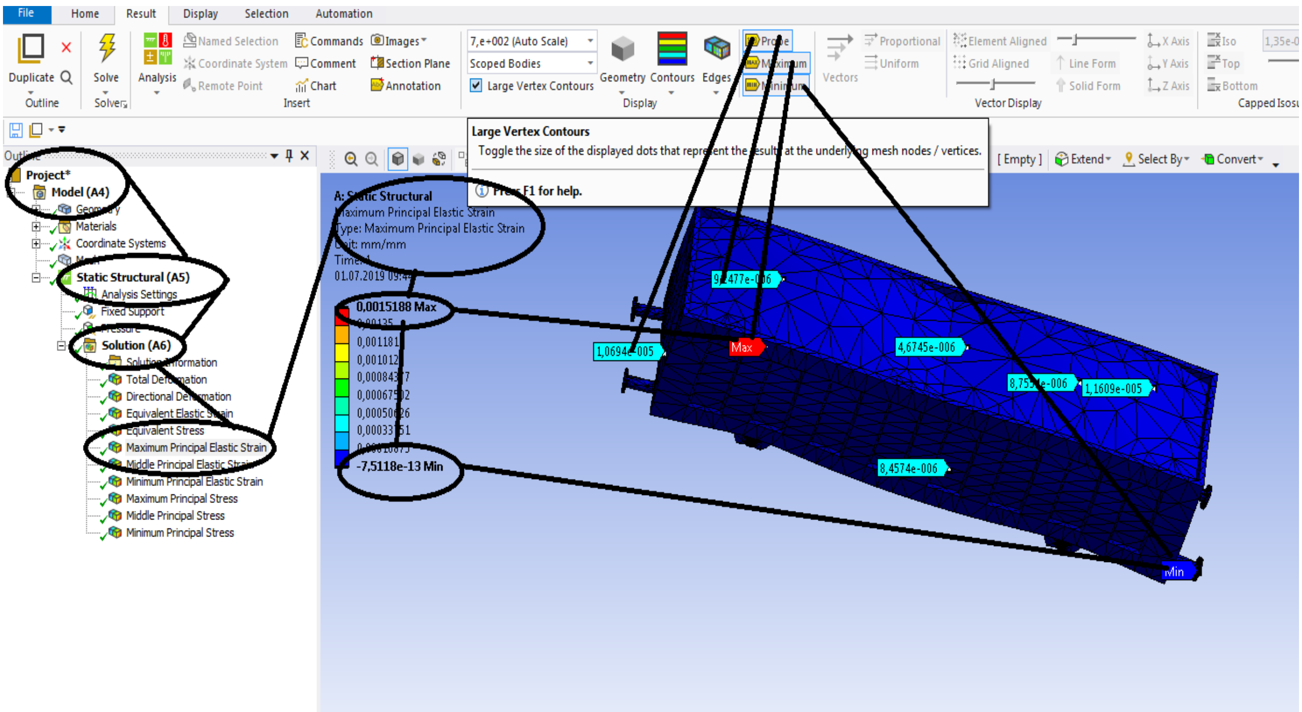


Figura 238 - Deformațiile specifice principale - ε1 [mm/mm]

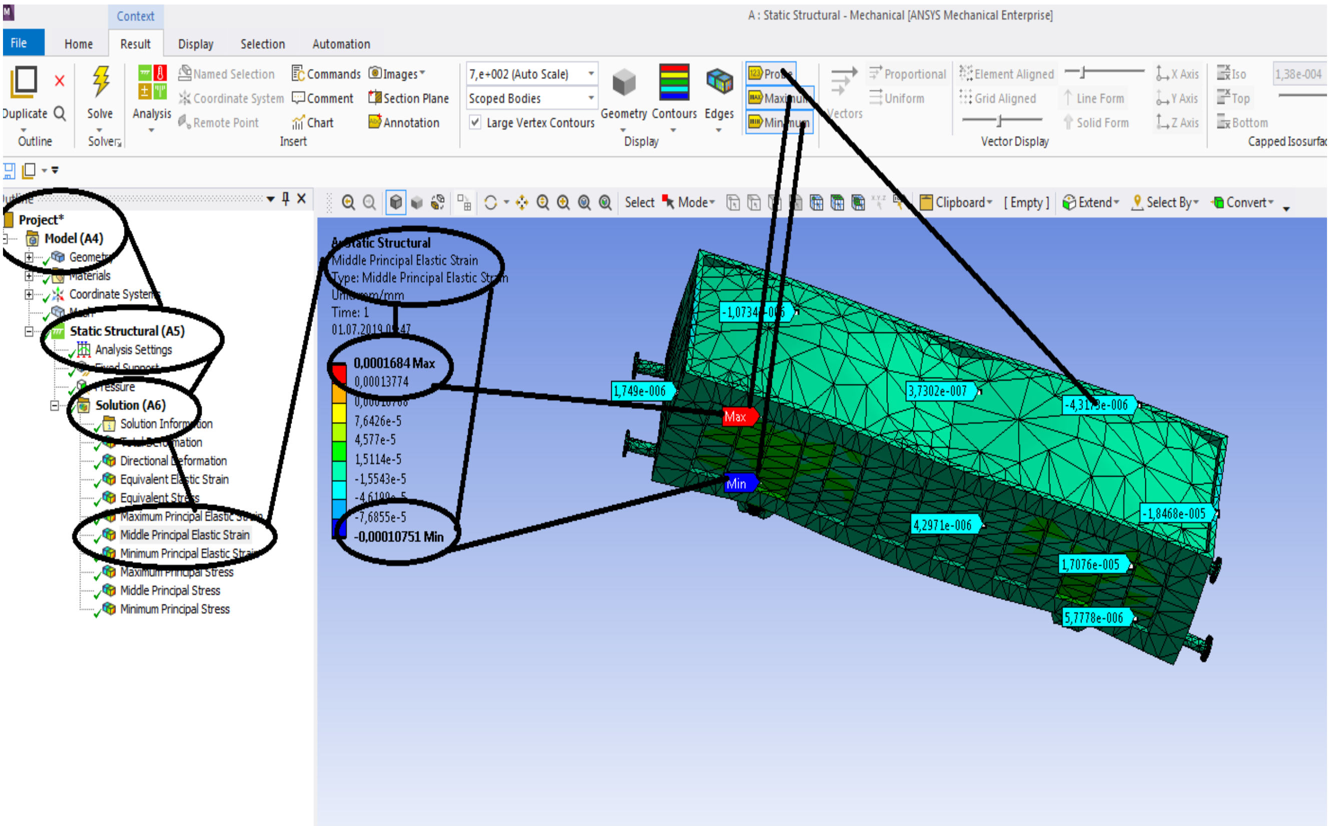


Figura 239 - Deformațiile specifice principale ε2 [mm/mm]

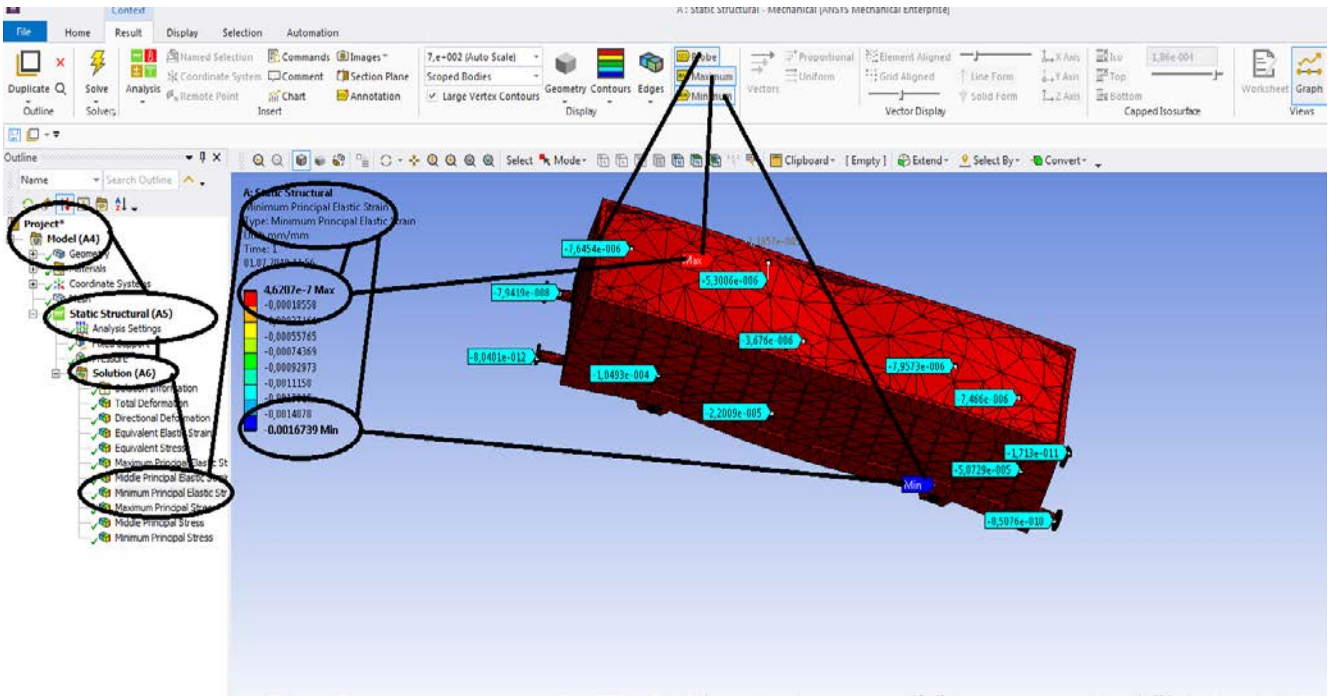


Figura 240 - Deformațiile specifice principale ε3 [mm/mm]

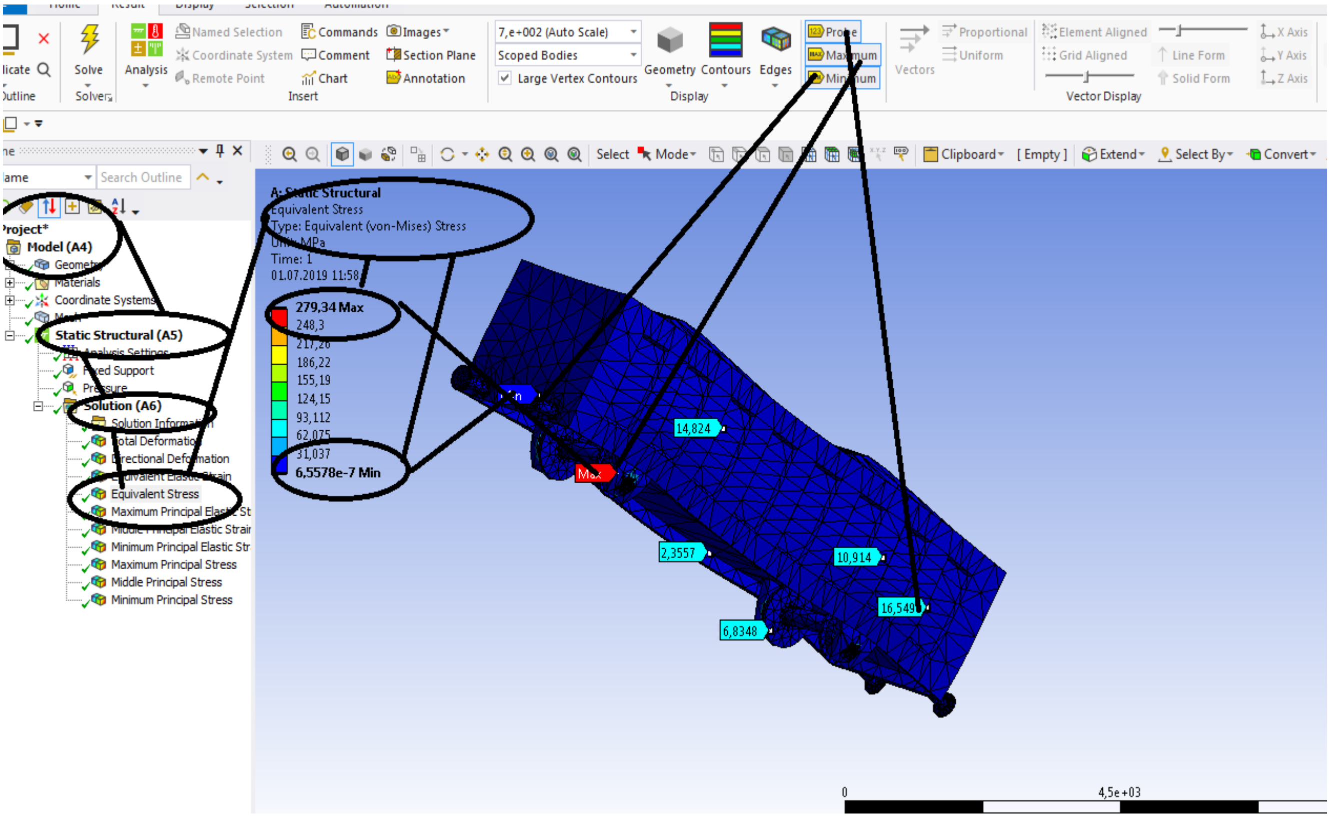


Figura 241 - Tensiunile echivalente von Mises [MPa]

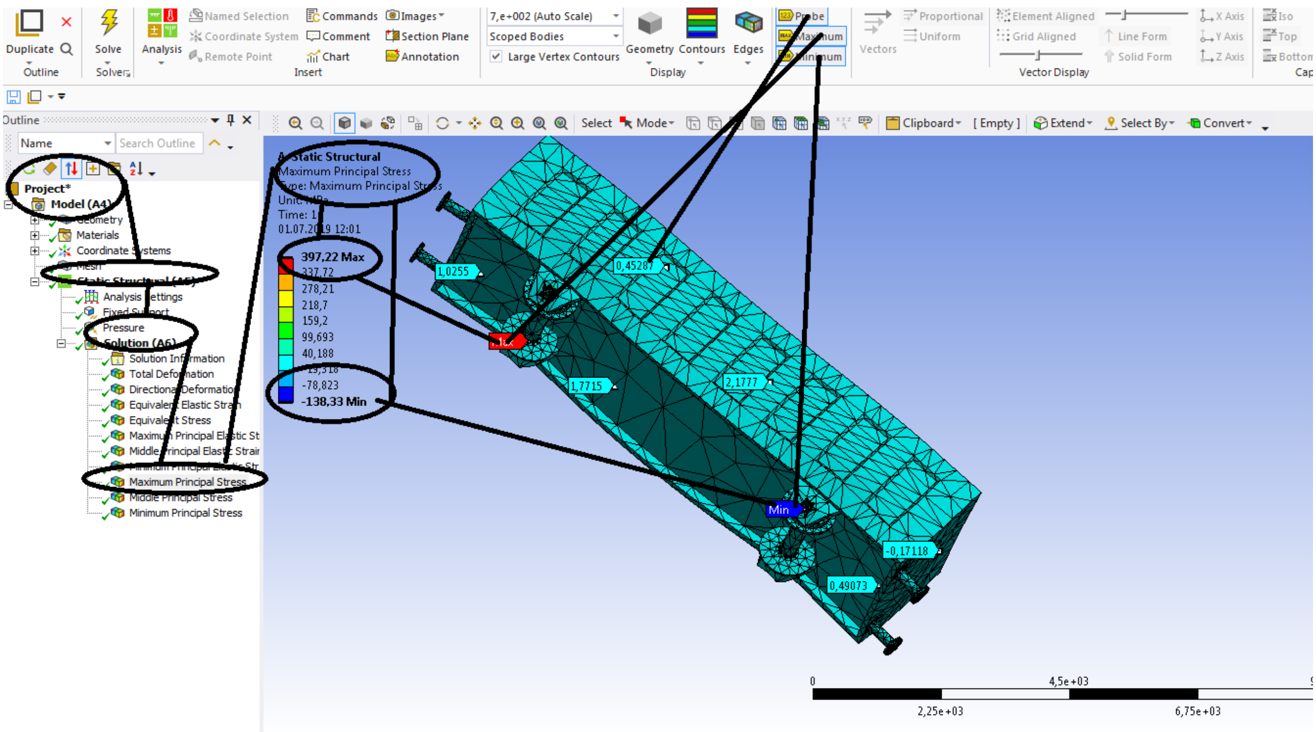


Figura 242 - Tensiunile principale $\sigma 1$ [MPa]

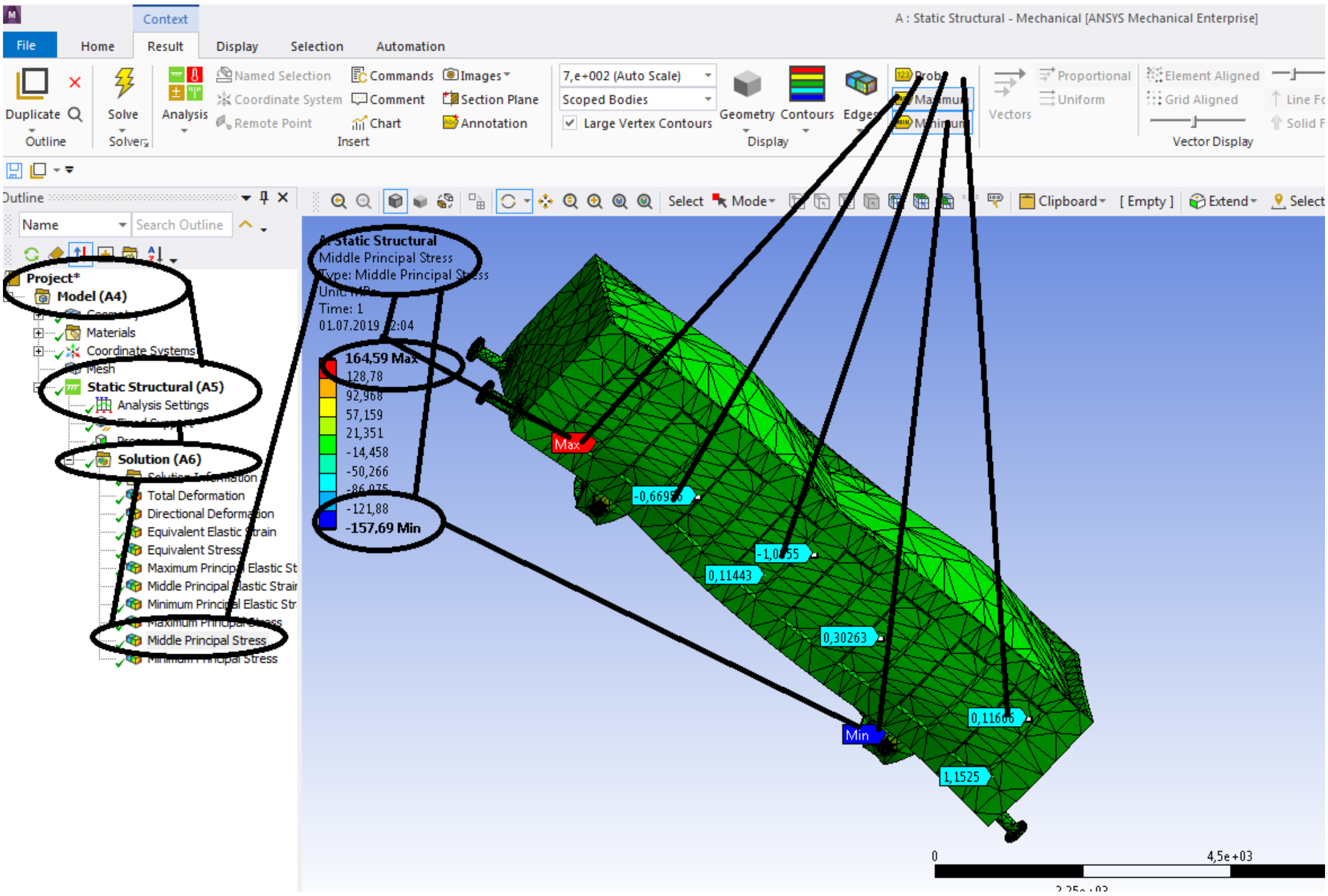


Figura 243 - Tensiunile principale $\sigma 2$ [MPa]

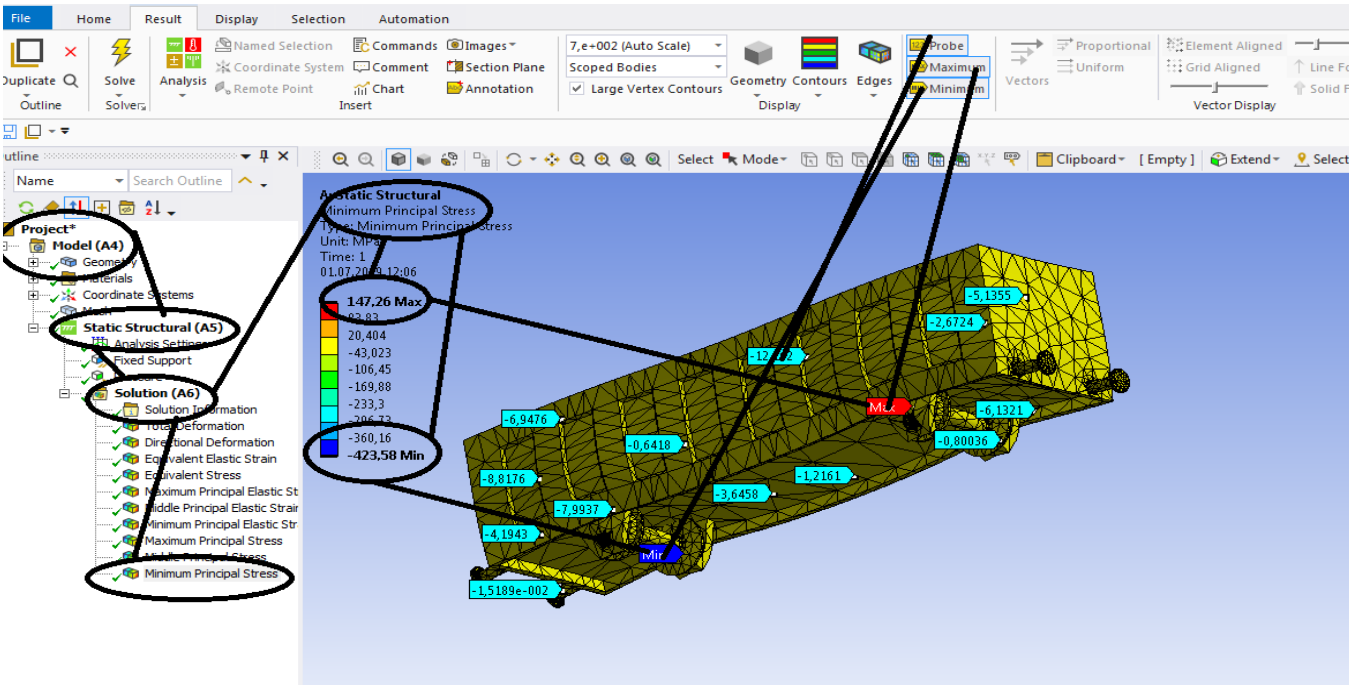


Figura 244 -Tensiunile principale $\sigma 3$ [MPa]

4.2 Static structural termic pentru vagon cale ferata

Rezultate

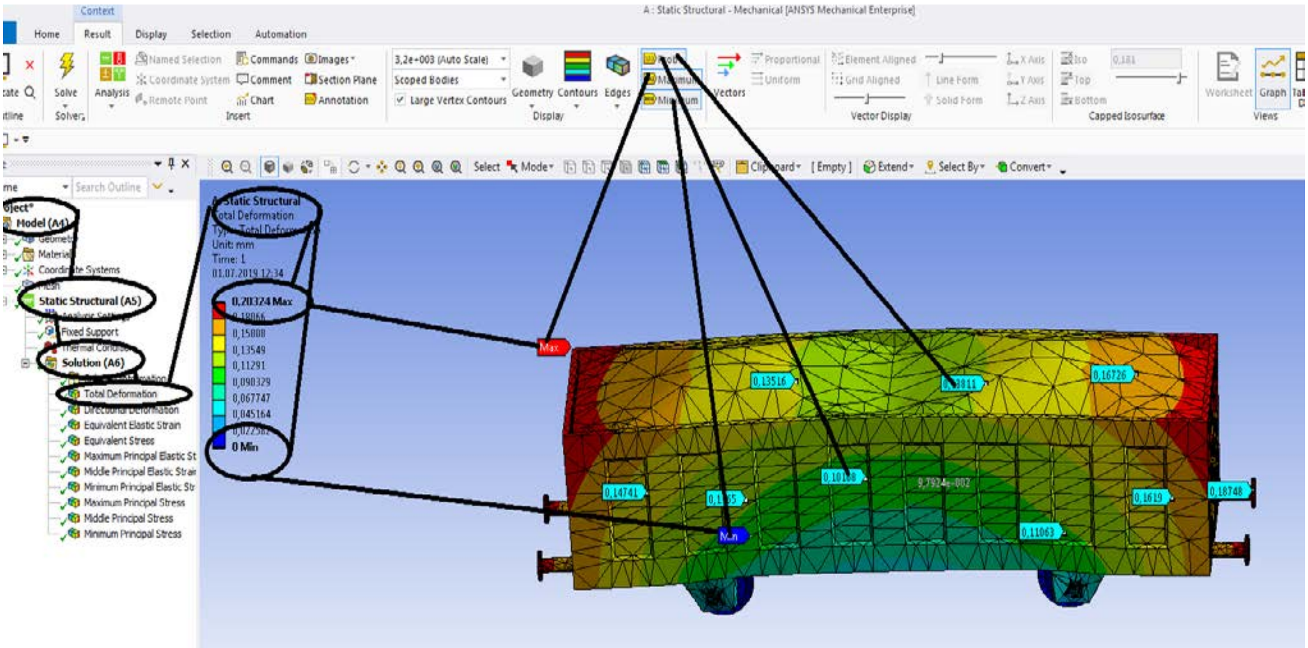


Figura 245 - Deformații totale [mm]

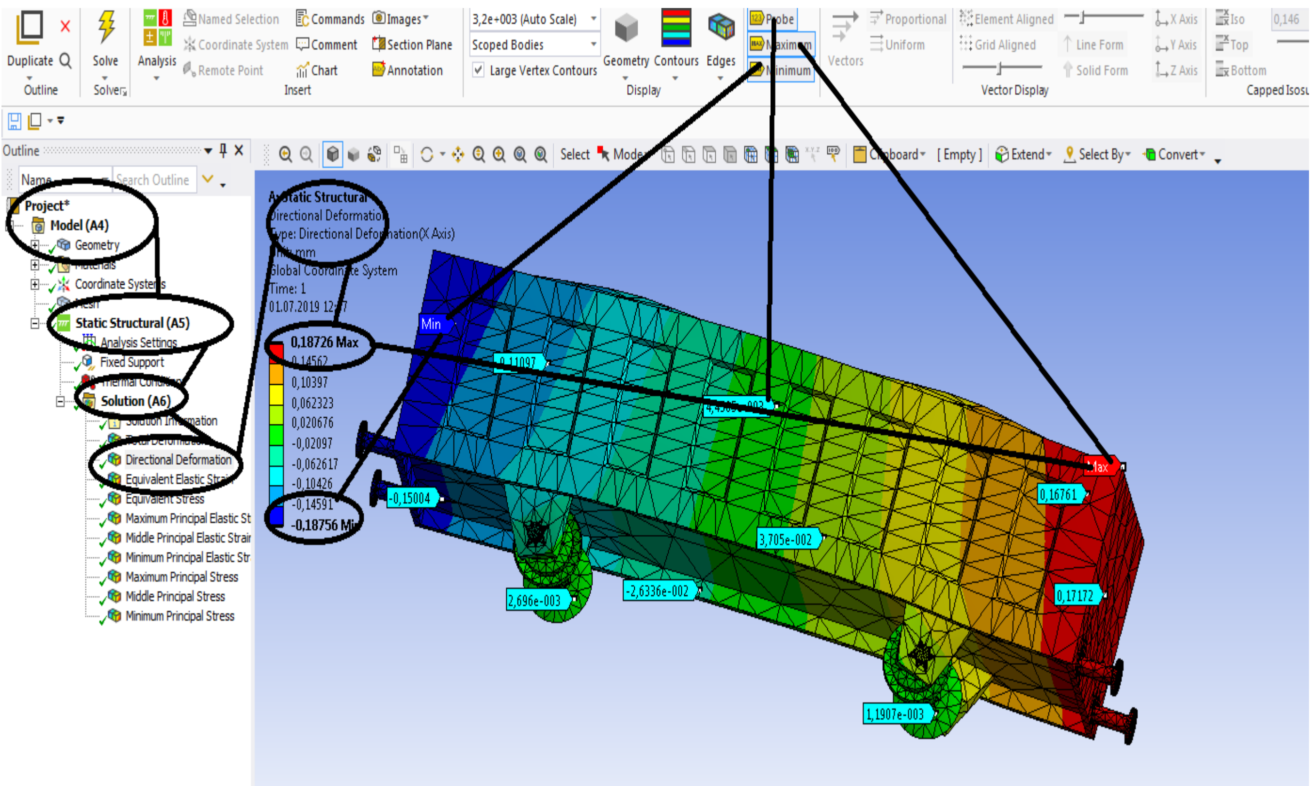


Figura 246 - Deformații direcționale pe axa x [mm]

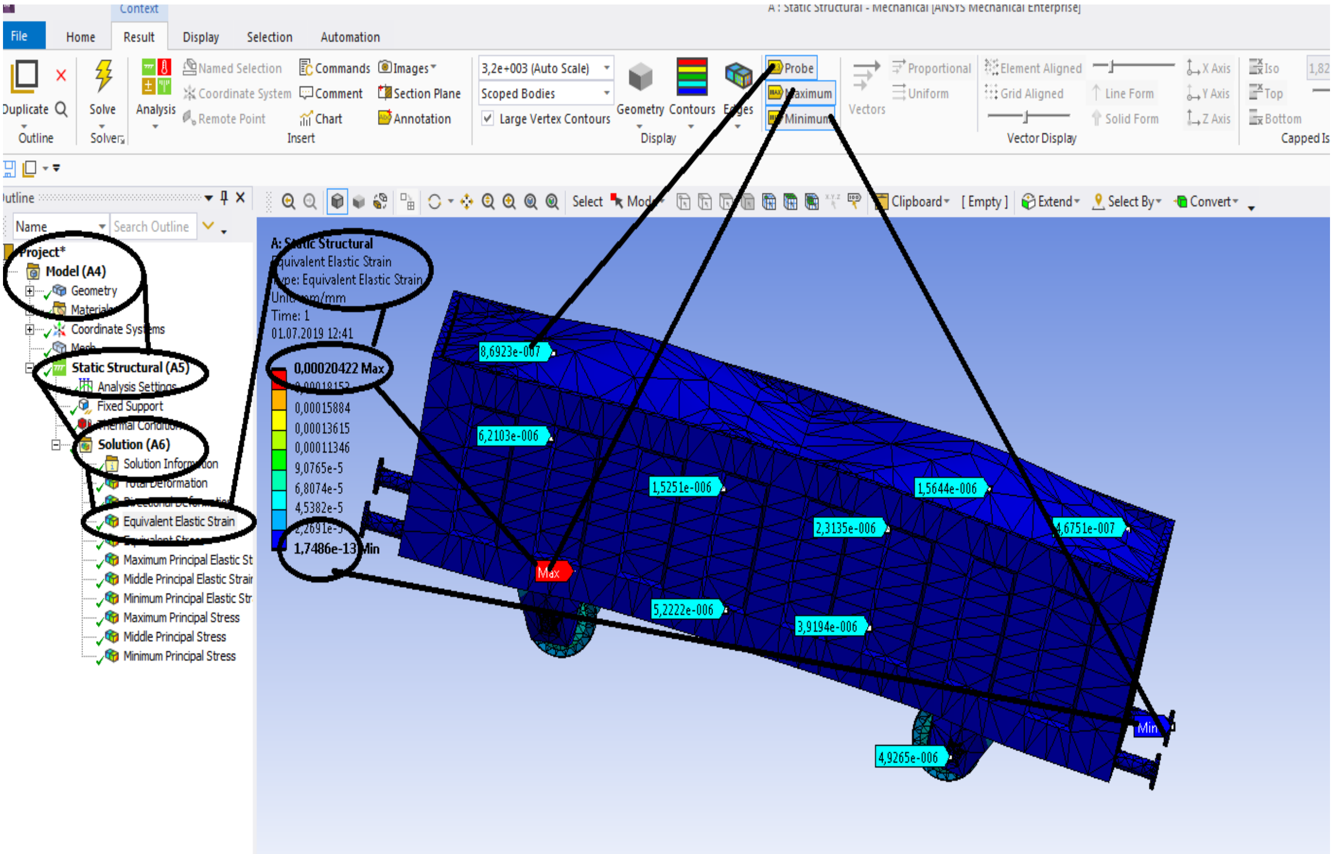


Figura 247 - Deformațiile specifice echivalente ε [mm/mm]

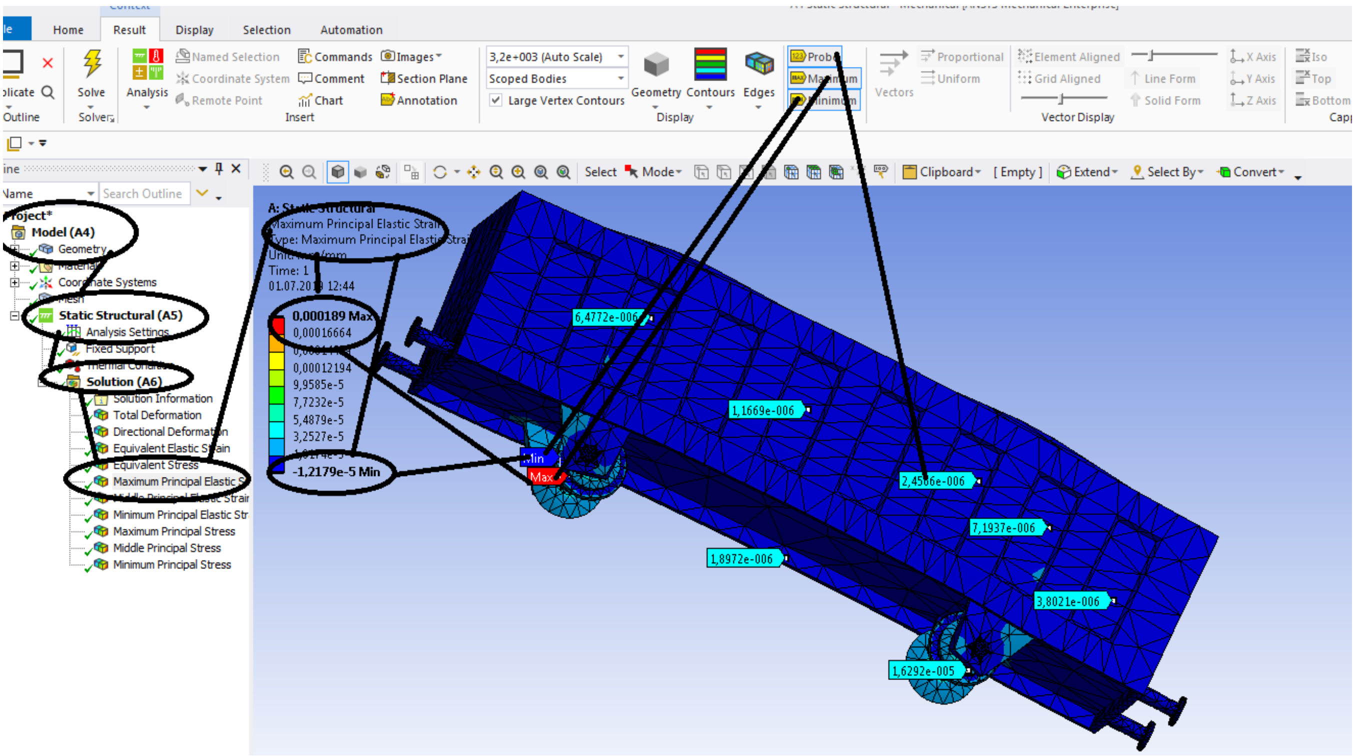


Figura 248 - Deformațiile specifice principale - ε1 [mm/mm]

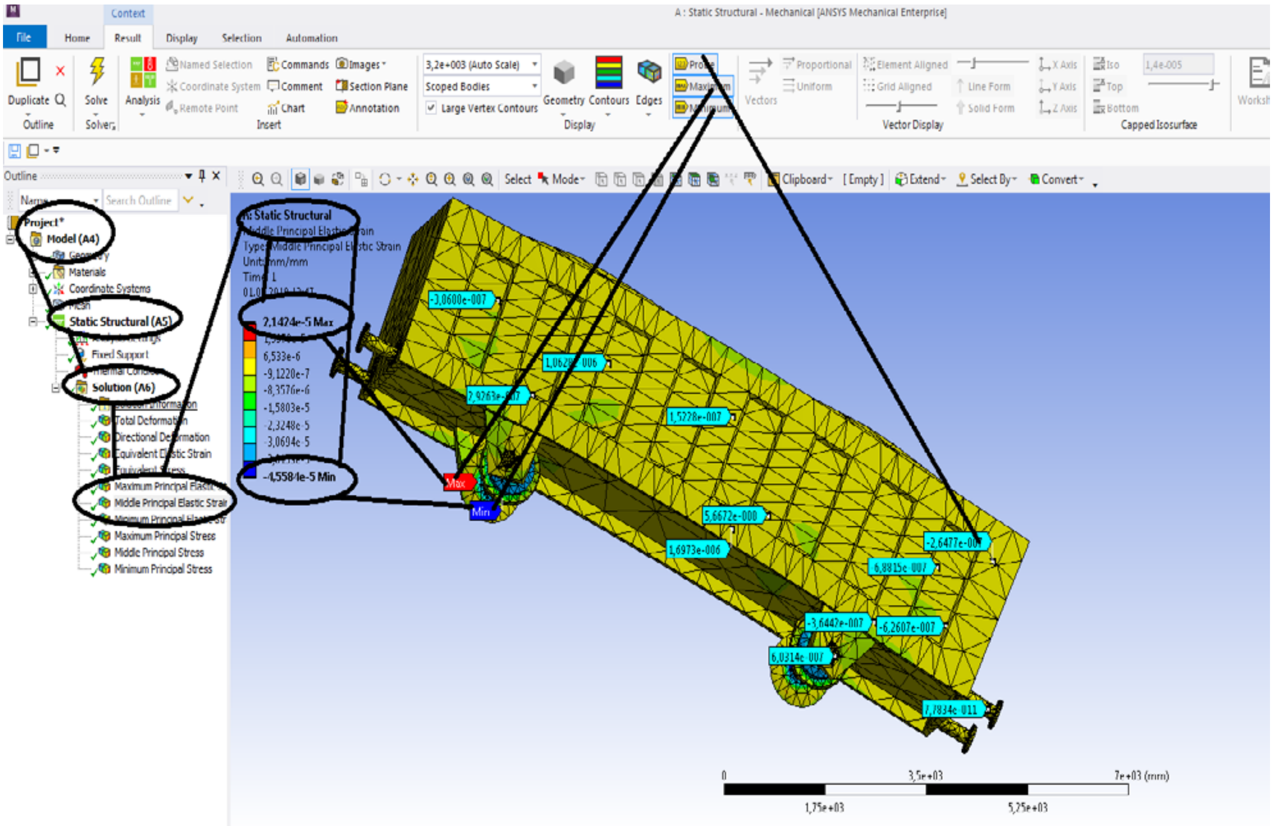


Figura 249 - Deformațiile specifice principale ε2 [mm/mm]

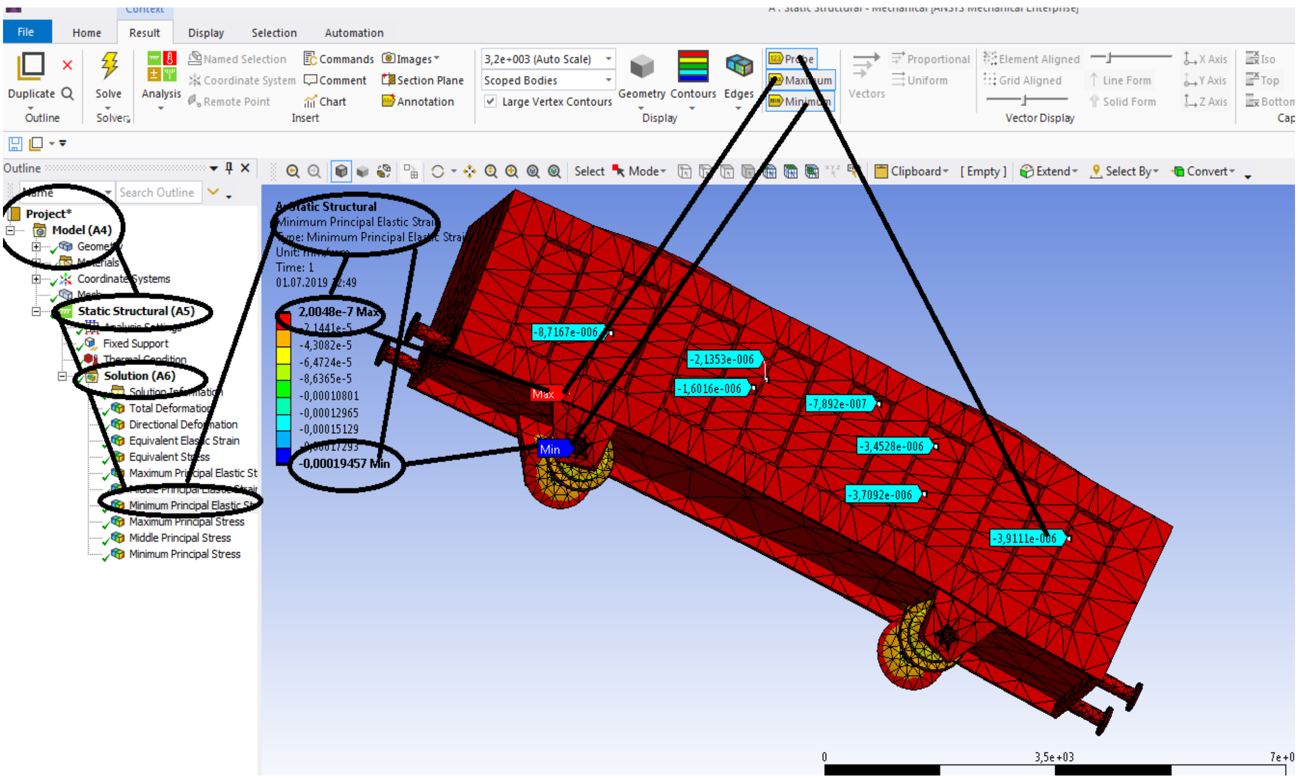


Figura 250 - Deformațiile specifice principale ε3 [mm/mm]

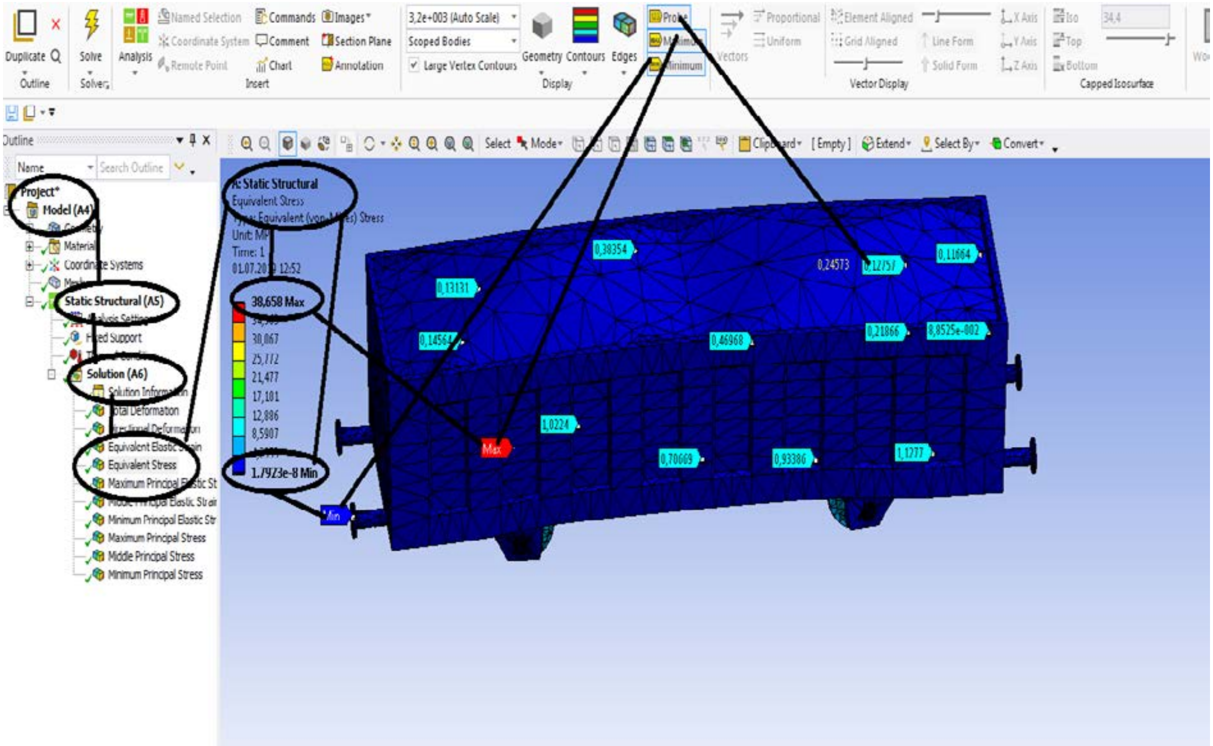


Figura 251 - Tensiunile echivalente von Mises [MPa]

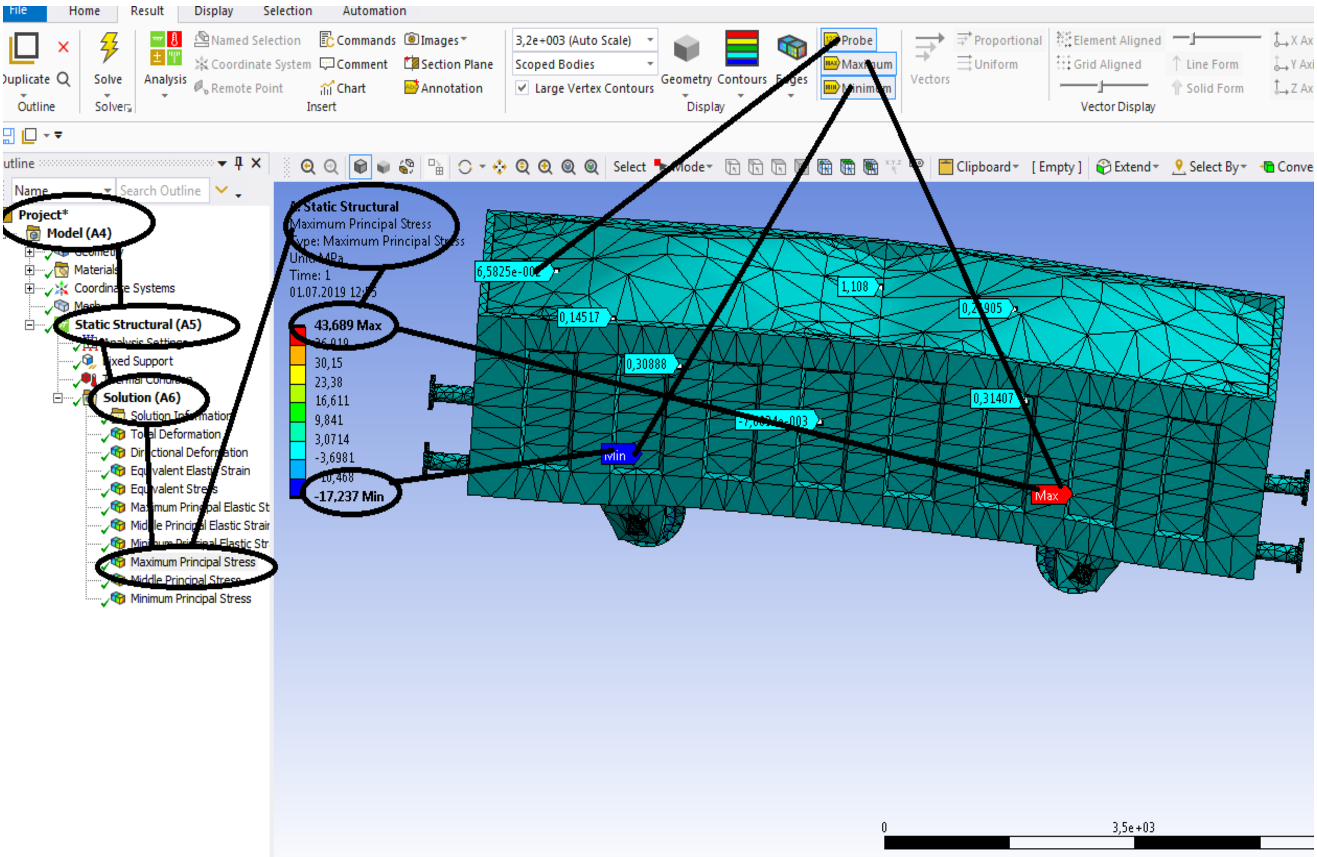


Figura 252 - Tensiunile principale $\sigma 1$ [MPa]

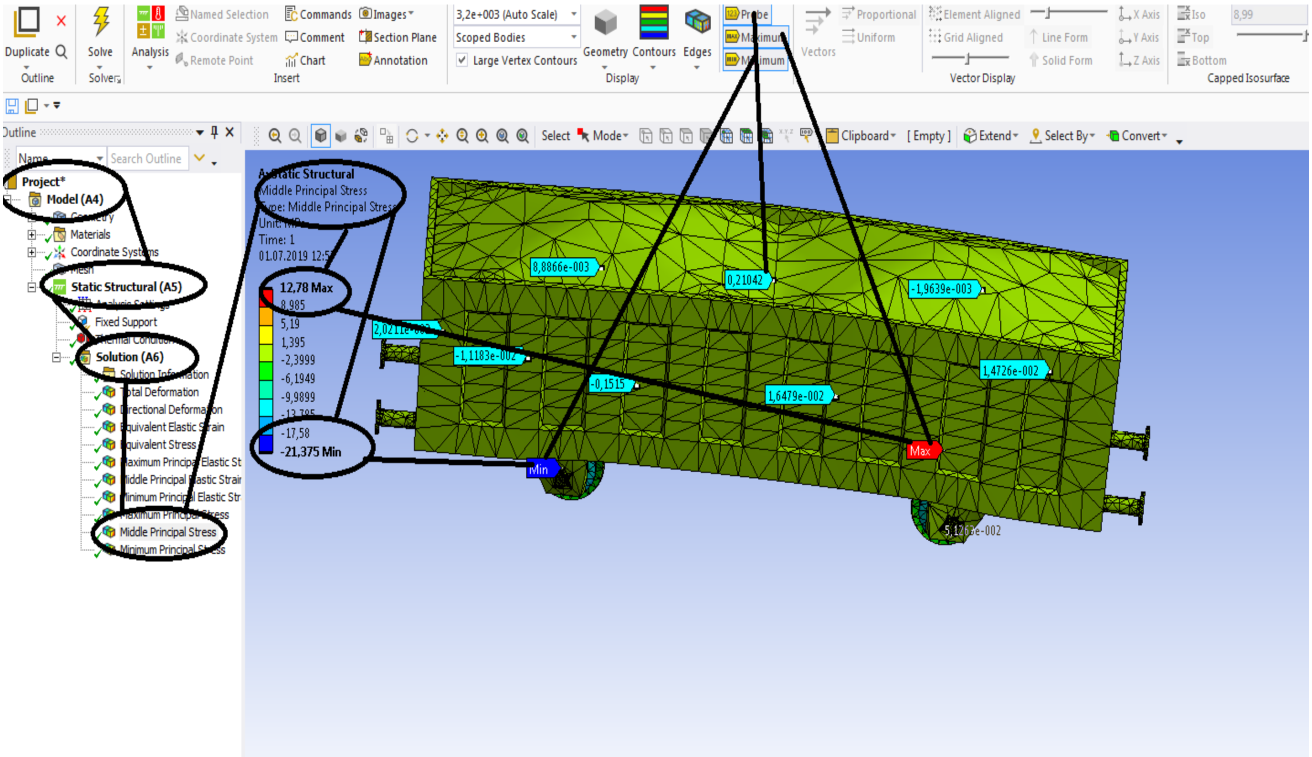


Figura 253 - Tensiunile principale $\sigma 2$ [MPa]

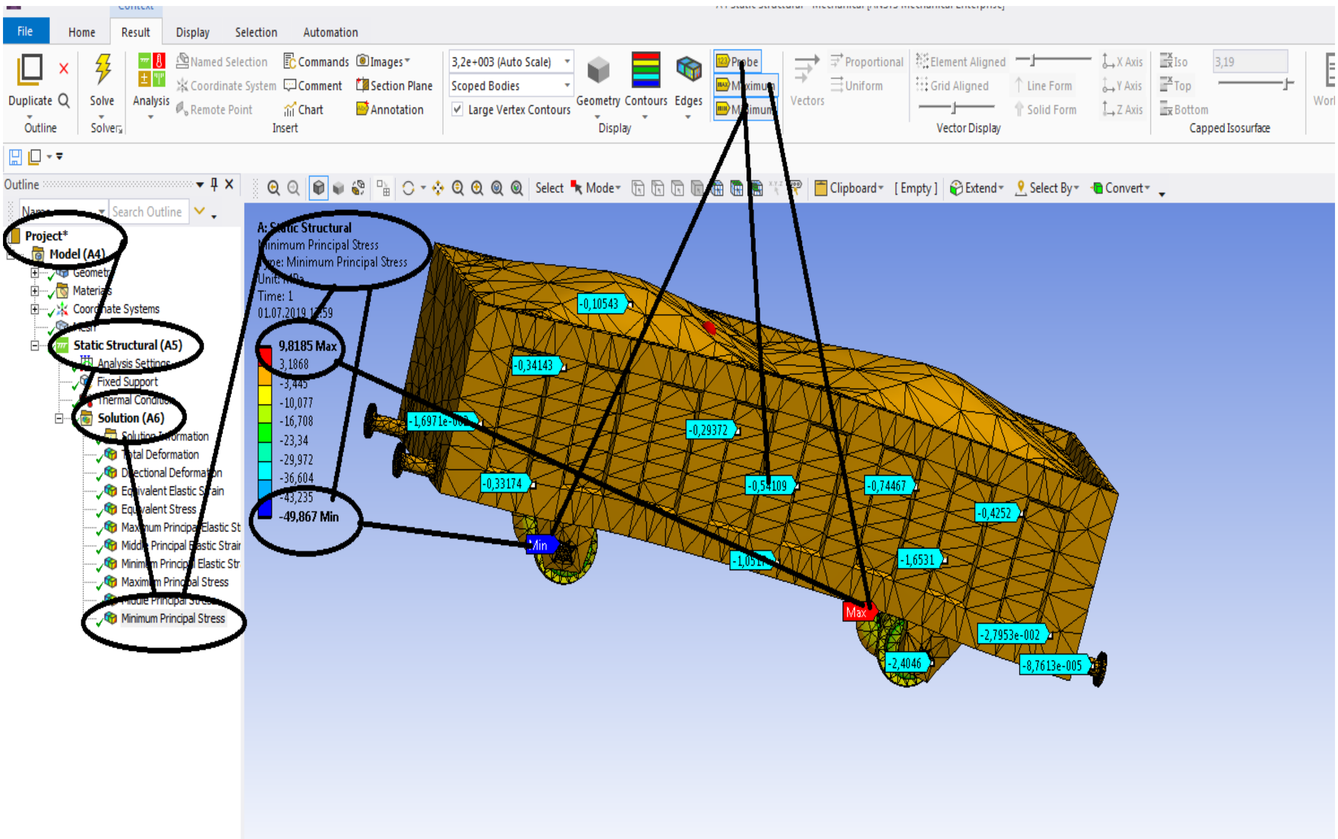


Figura 254 -Tensiunile principale $\sigma 3$ [MPa]

4.3 Static structural mecanic si termic pentru vagon cale ferata

-Rezultate

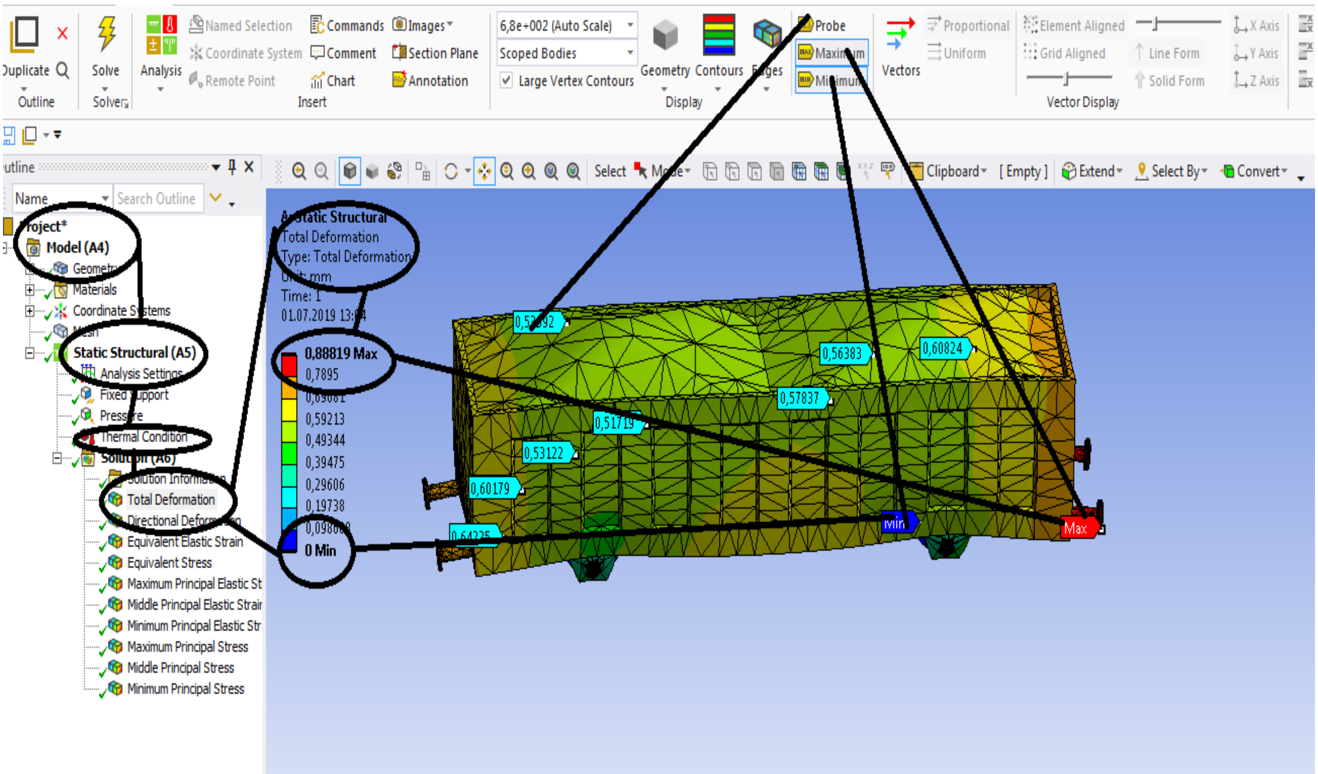


Figura 255 - Deformații totale [mm]

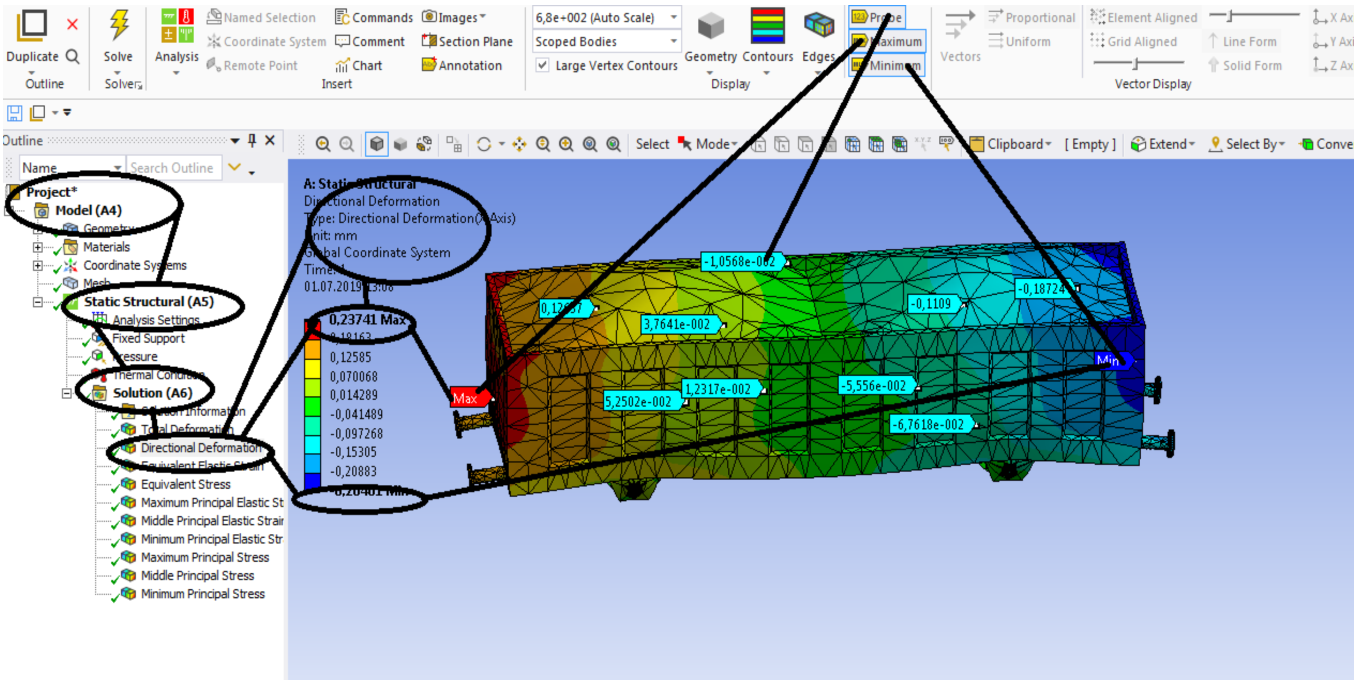


Figura 256 - Deformații direcționale pe axa x [mm]

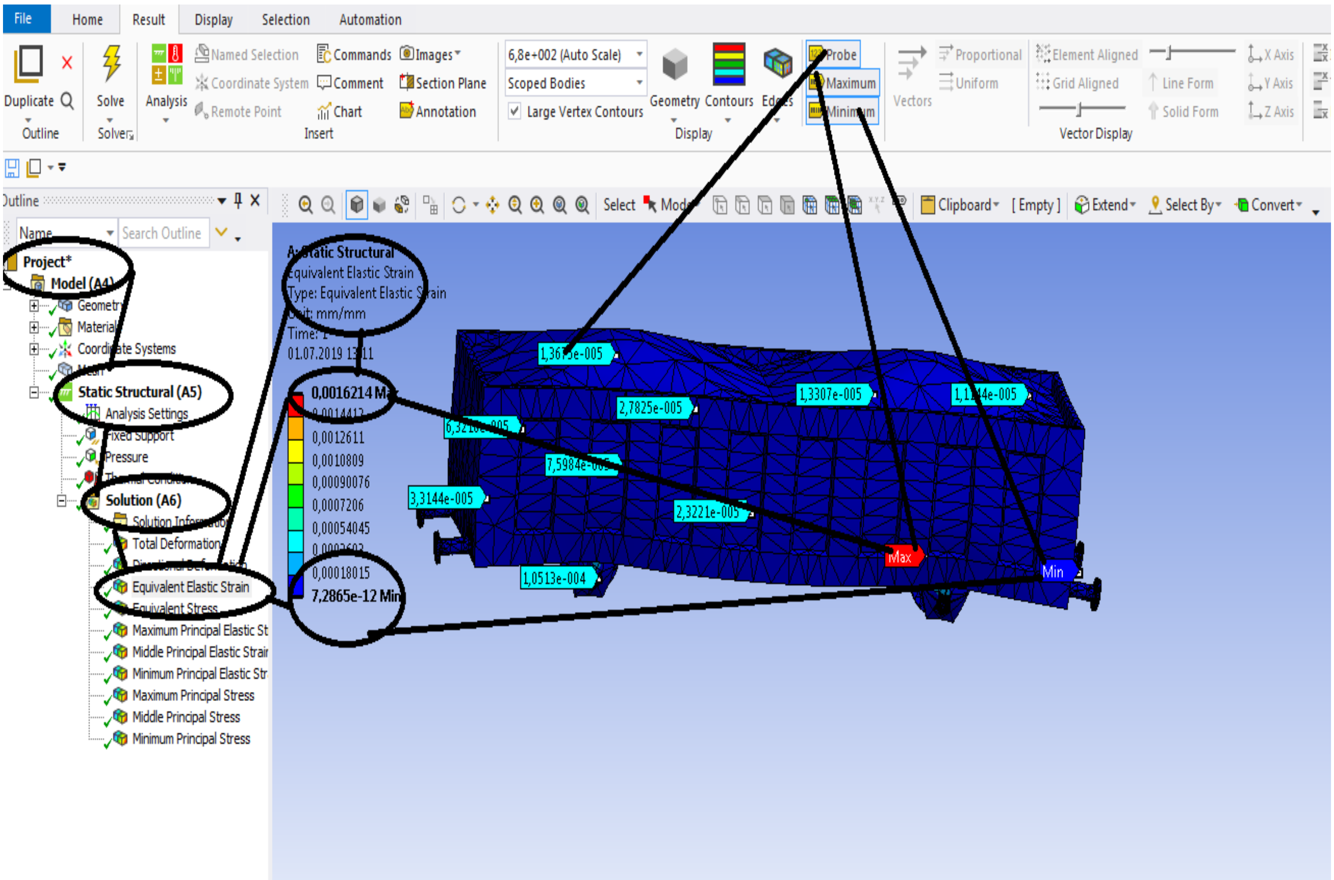


Figura 257 - Deformațiile specifice echivalente ε [mm/mm]

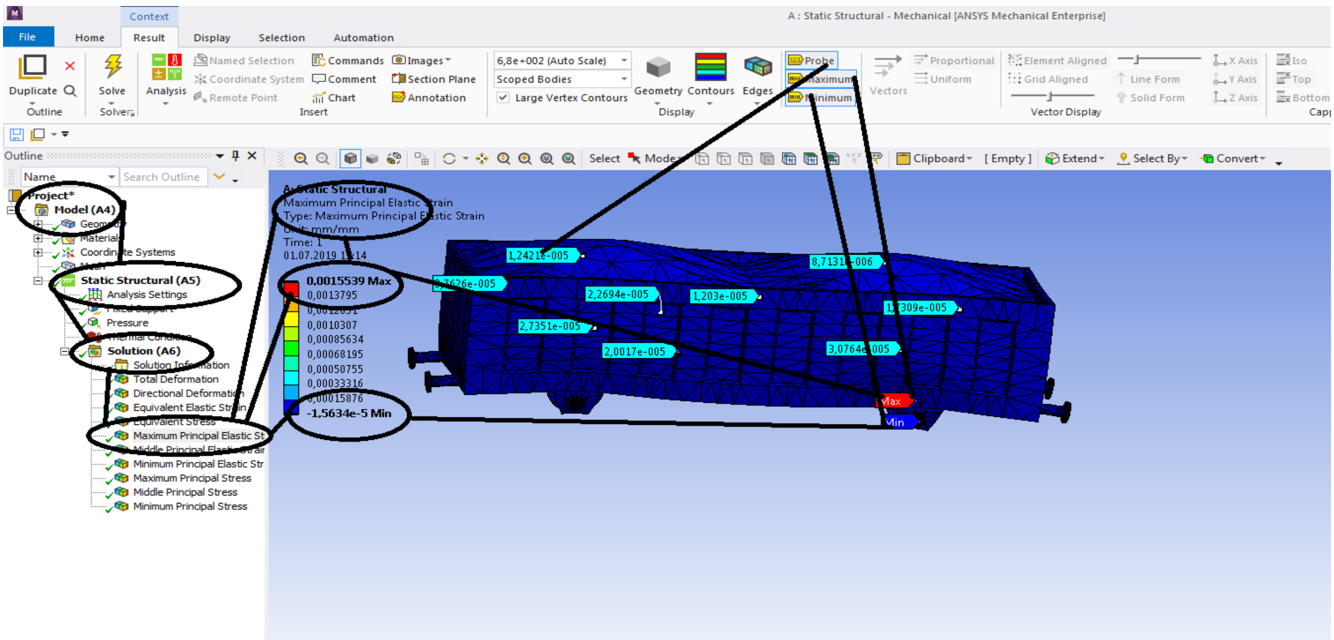


Figura 258 - Deformațiile specifice principale - ε1 [mm/mm]

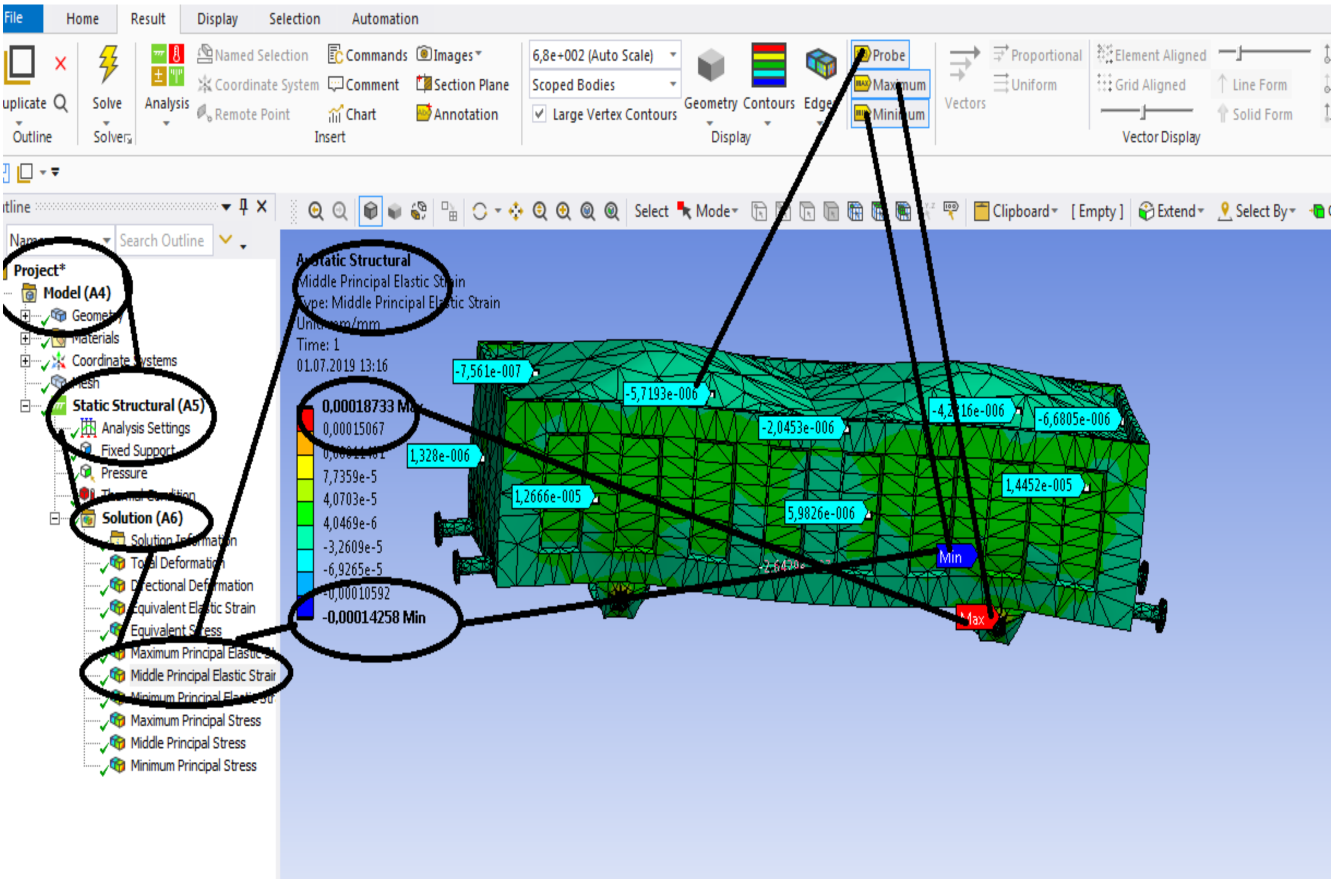


Figura 259 - Deformațiile specifice principale ε2 [mm/mm]

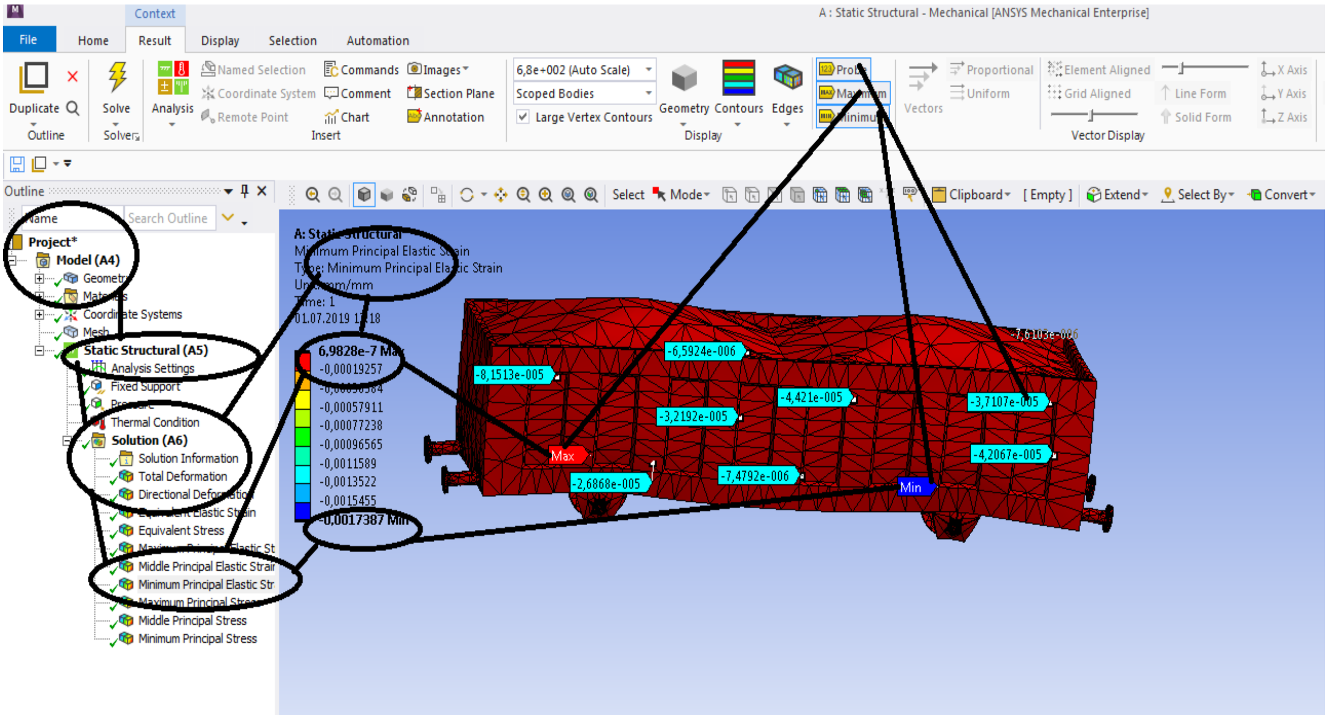


Figura 260 - Deformațiile specifice principale ε3 [mm/mm]

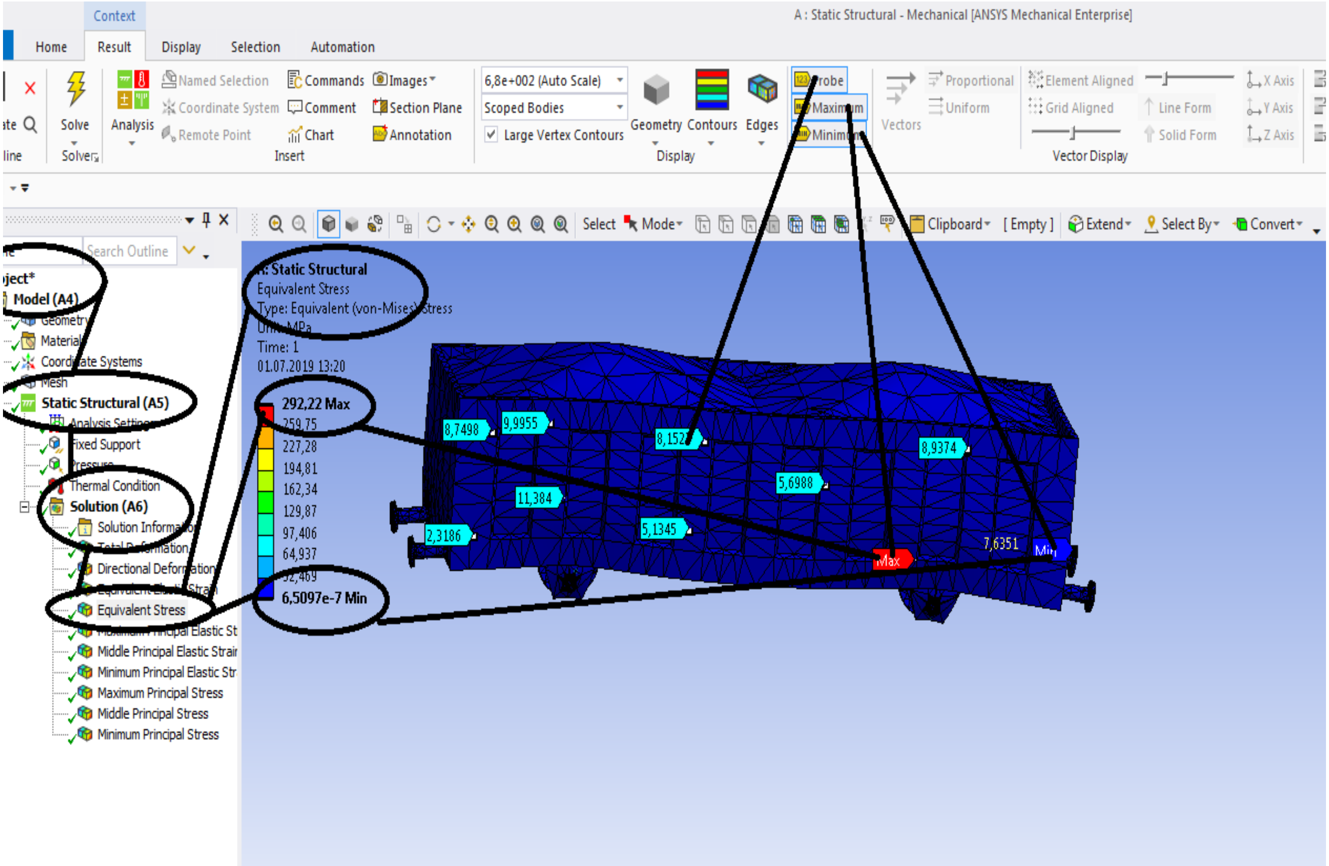


Figura 261 - Tensiunile echivalente von Mises [MPa]

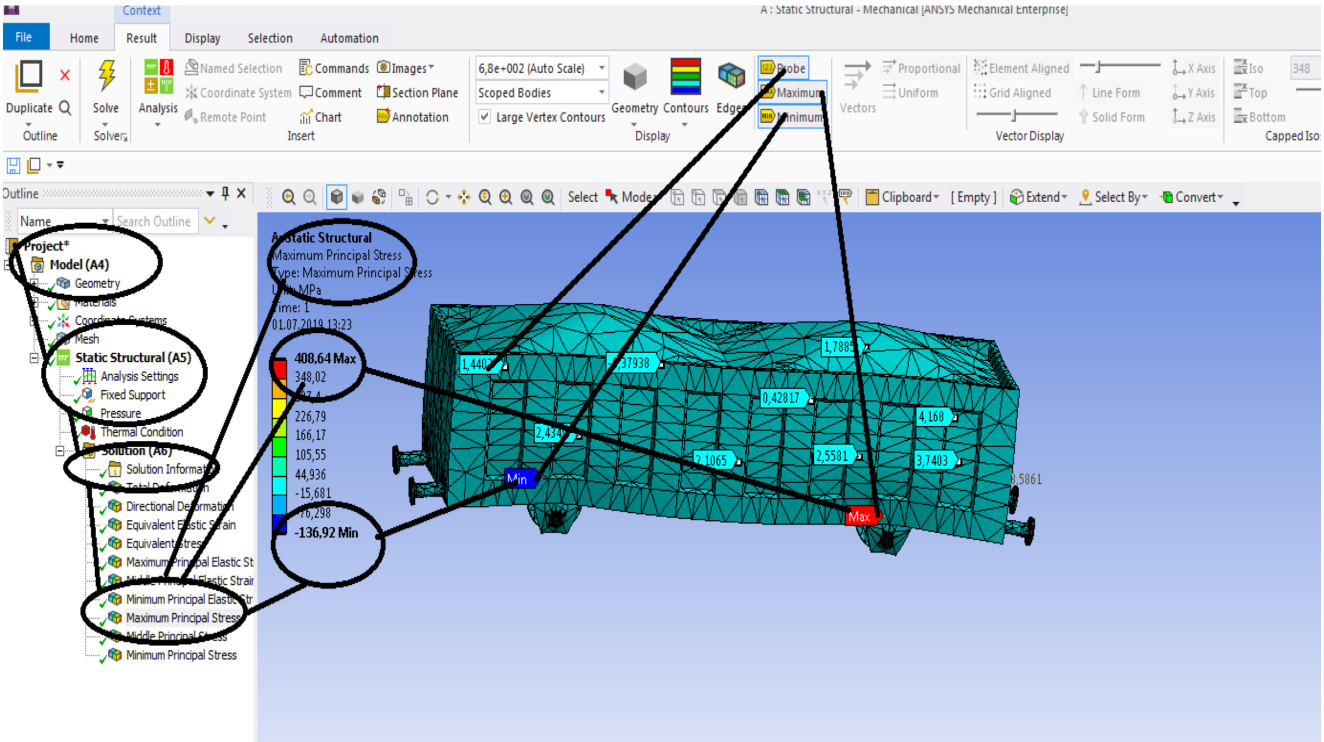


Figura 262 - Tensiunile principale $\sigma 1$ [MPa]

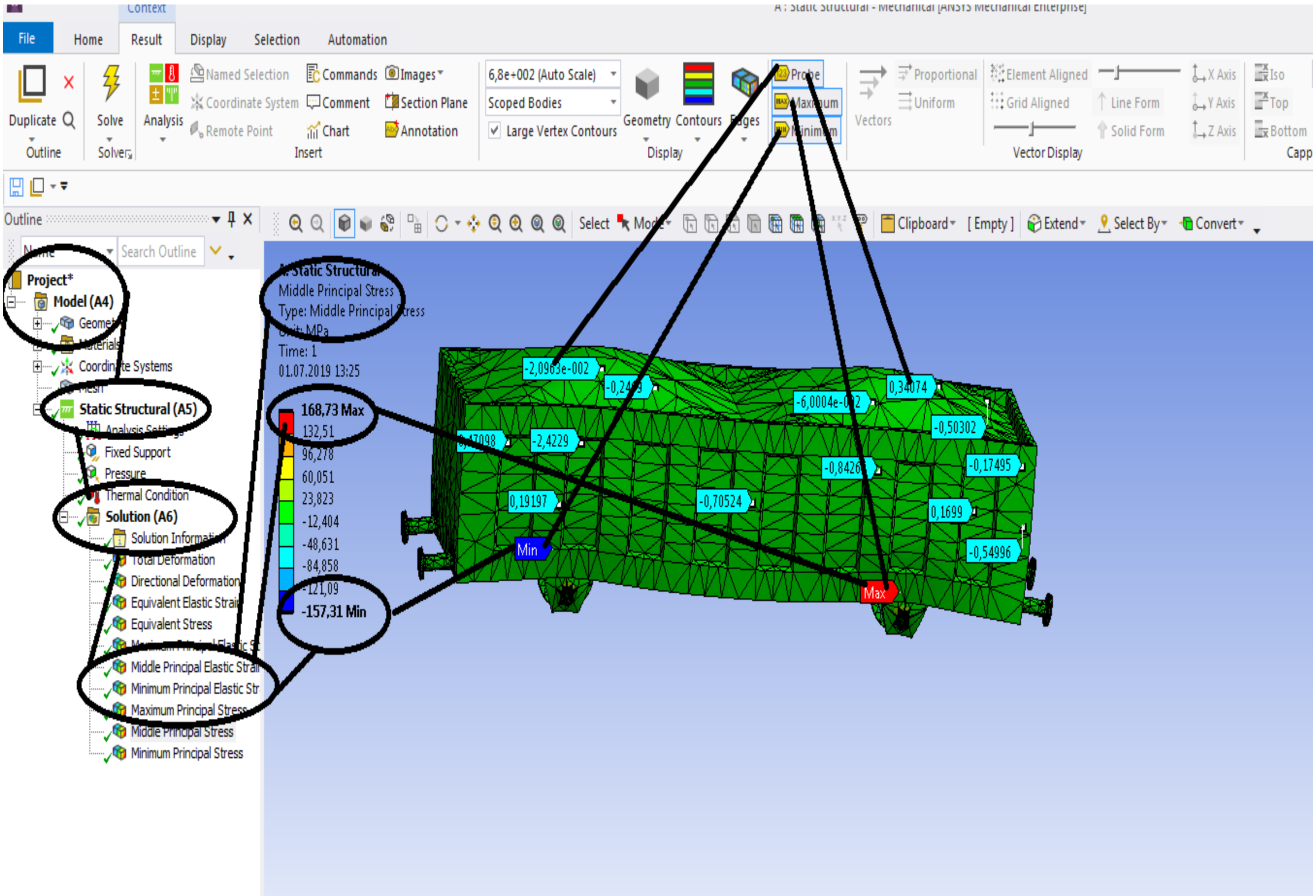


Figura 263 - Tensiunile principale $\sigma 2$ [MPa]

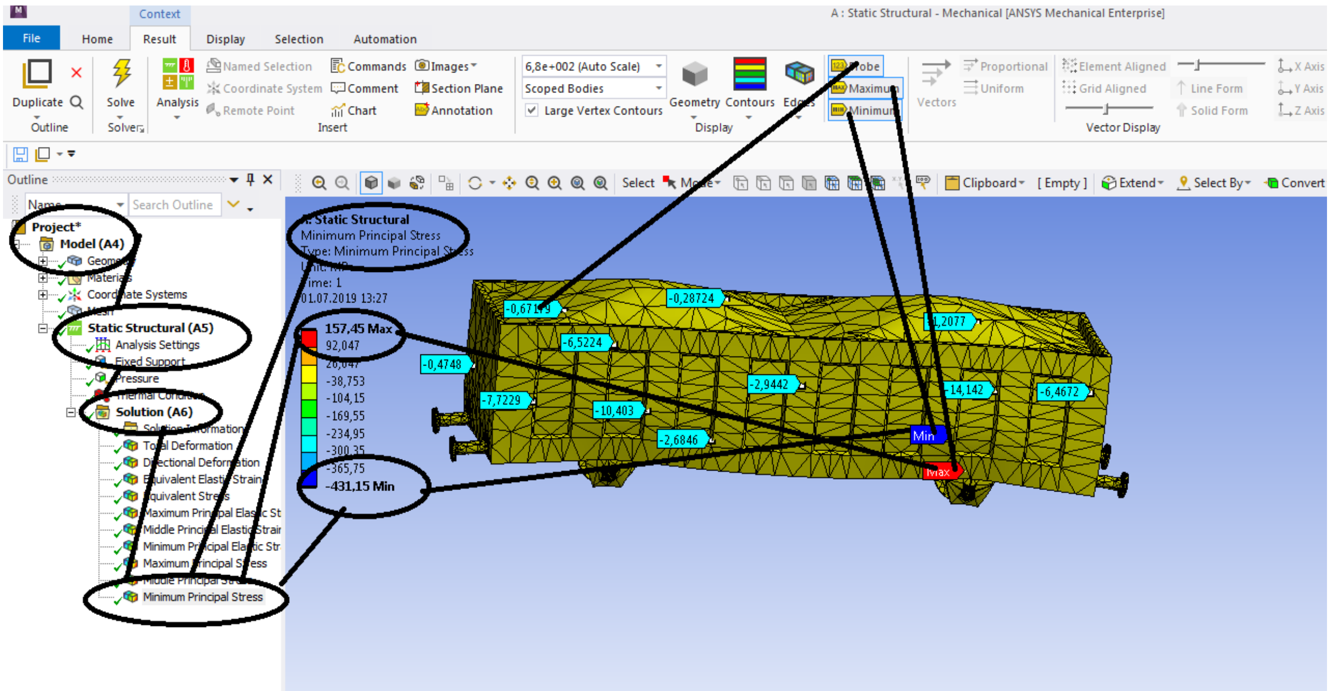


Figura 264 -Tensiunile principale $\sigma 3$ [MPa]

4.4 Solicitarea la oboseala pentru vagon cale ferata

- Rezultate

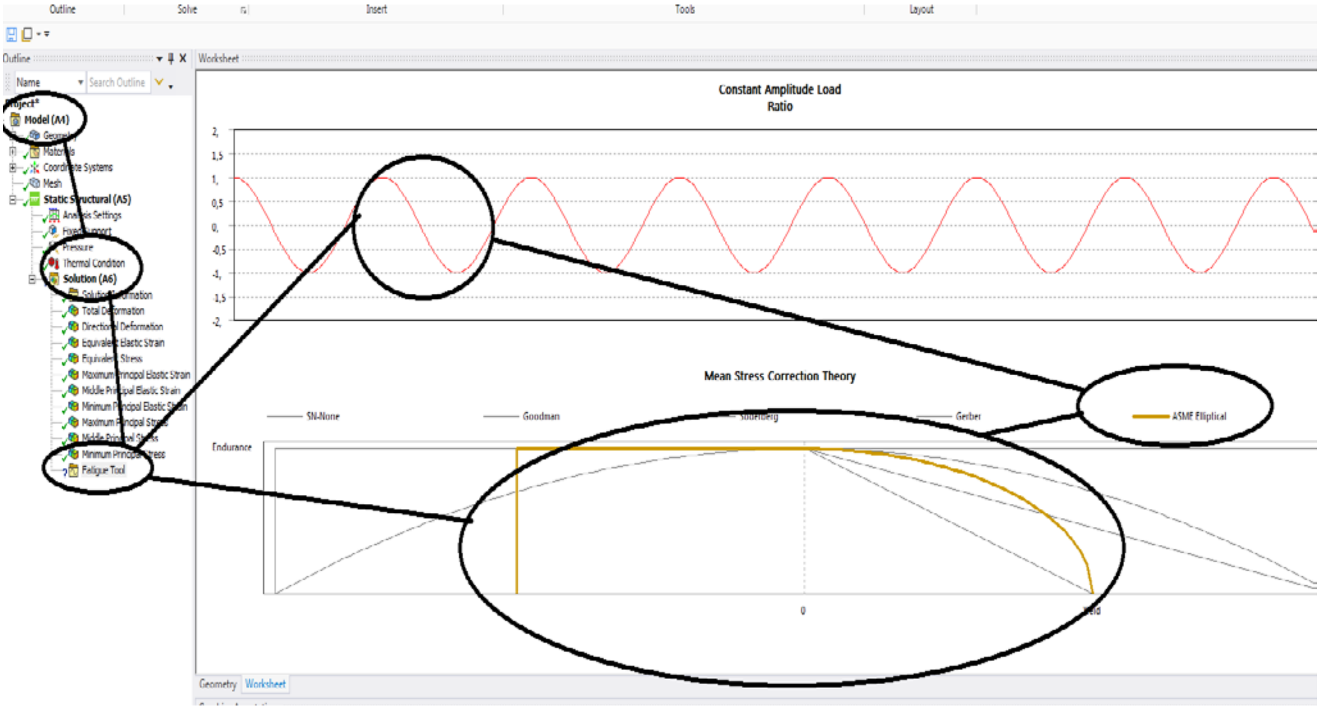


Figura 265 – Selectarea datelor de intrare

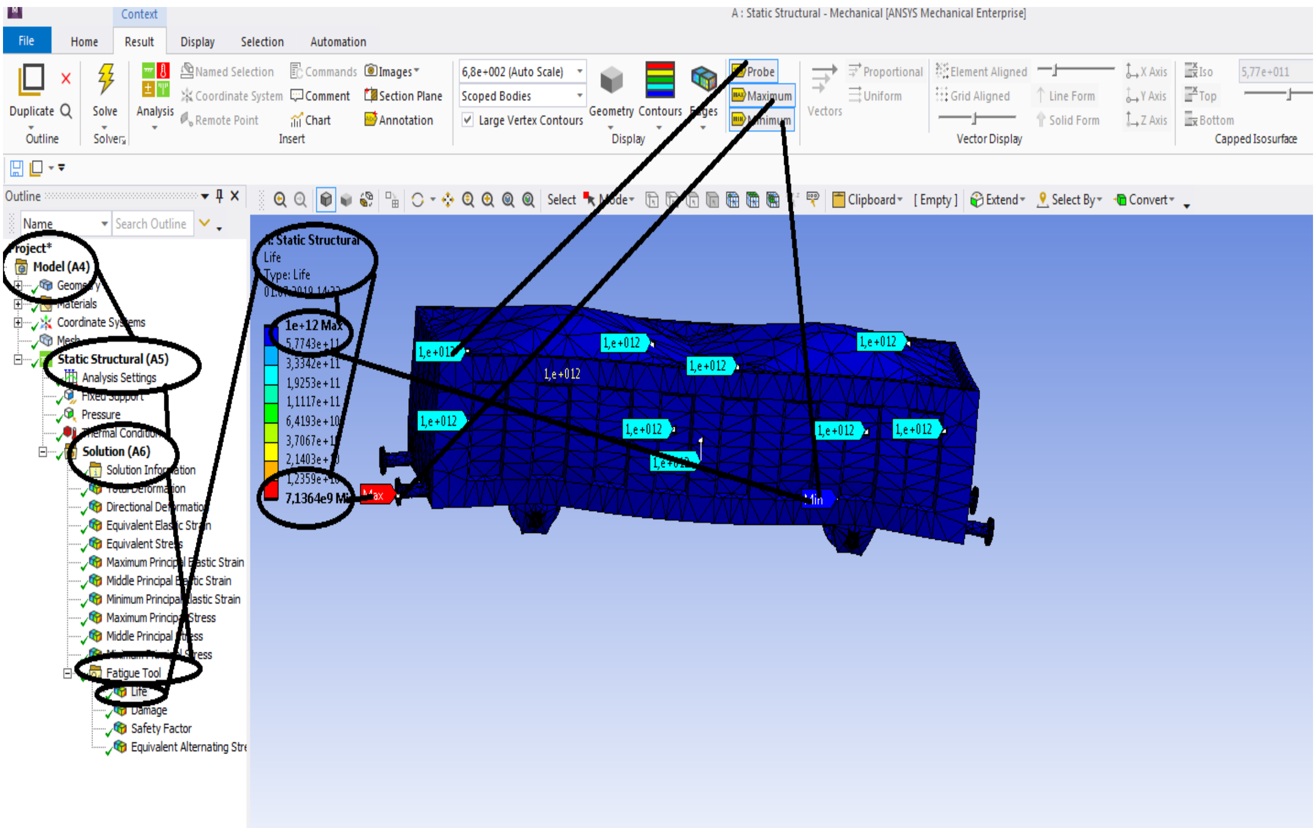


Figura 266 - Durata de viata [s]

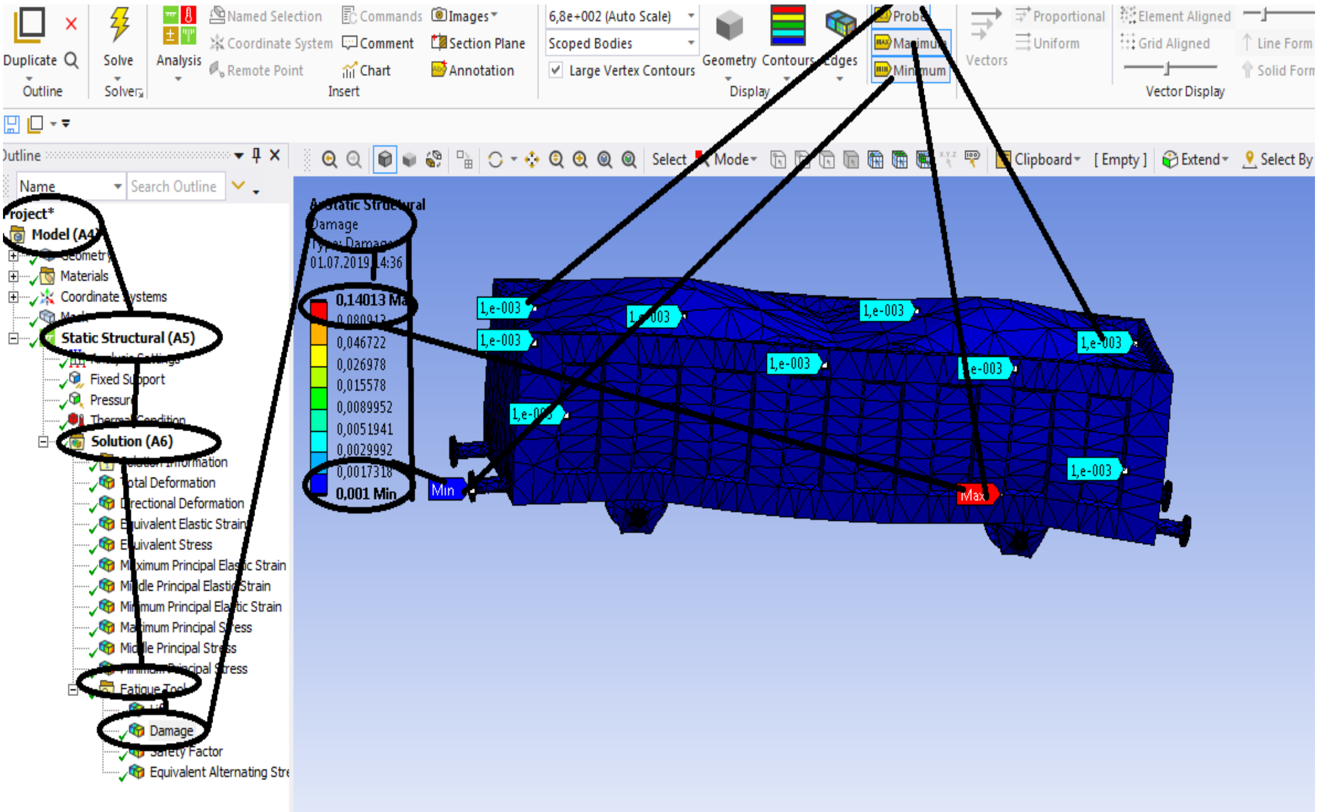


Figura 267 - Avarii [s]

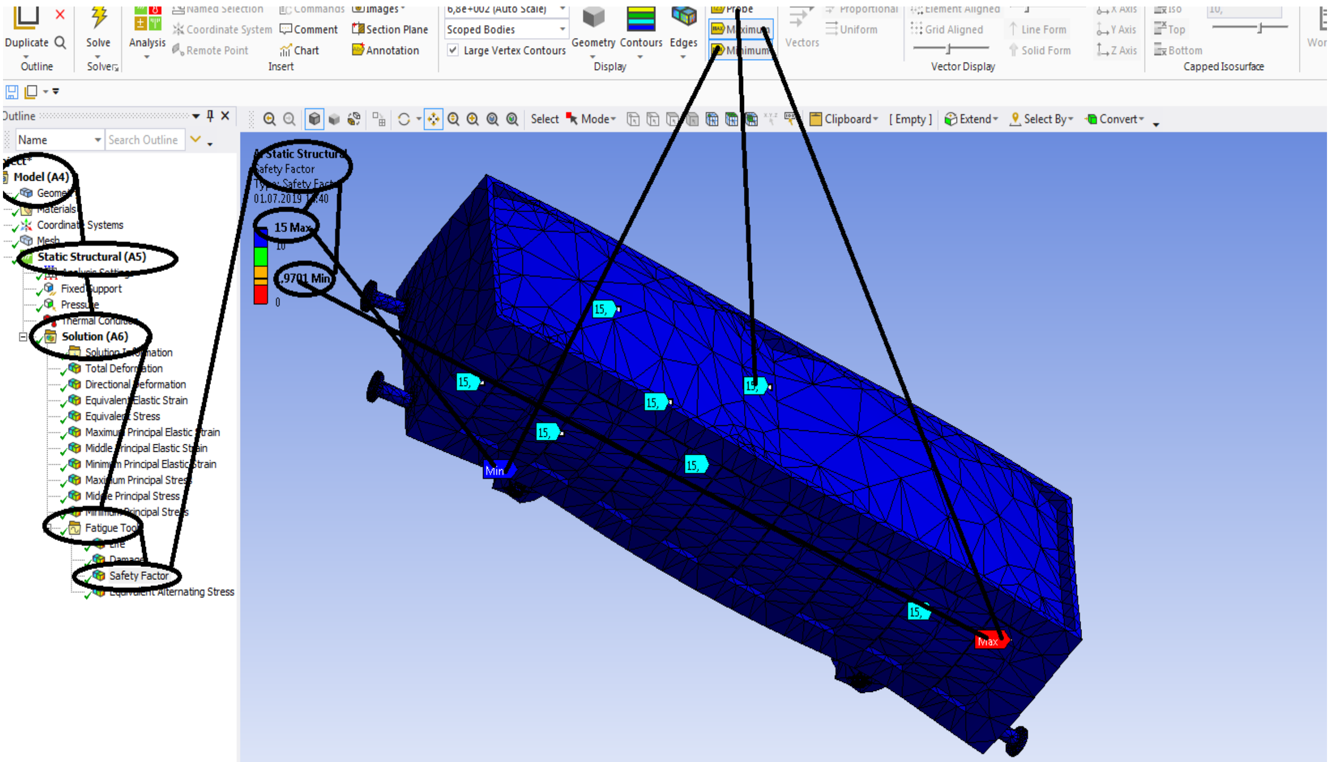


Figura 268 - Coeficientii de siguranta

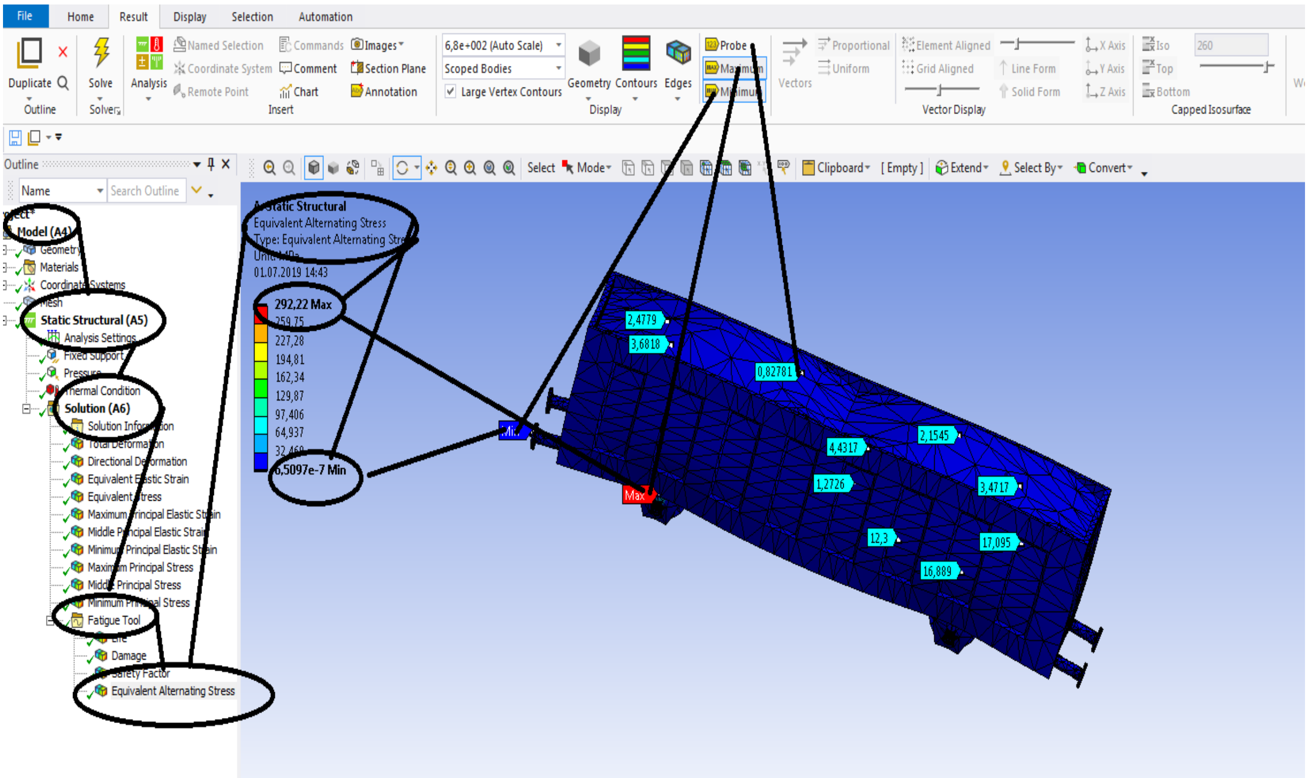


Figura 269 - Tensiunea la oboseala [MPa]

4.5 Solicitarea la vibratii mecanice a vagonului de cale ferata –Rezultate

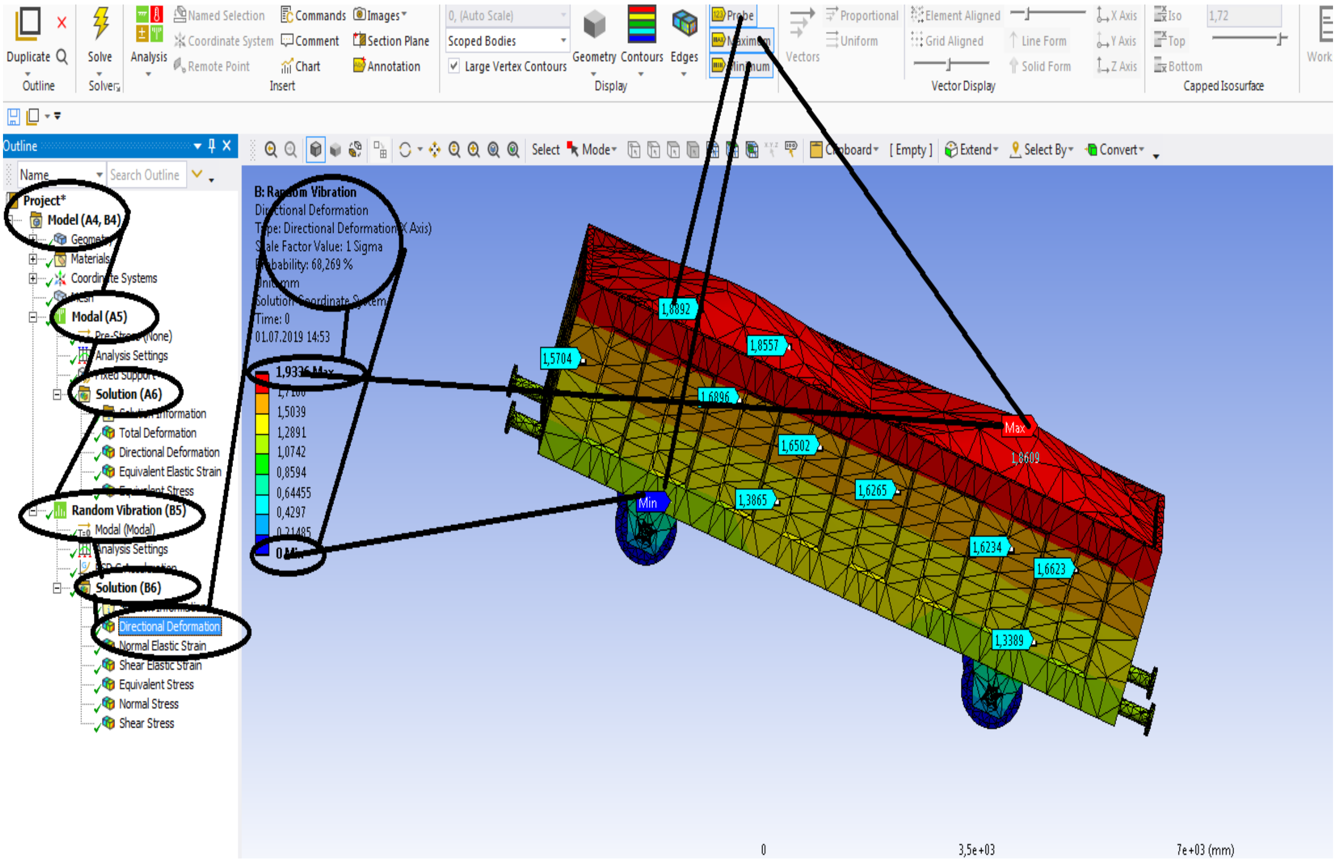


Figura 270 - Deformații direcționale pe axa x [mm]

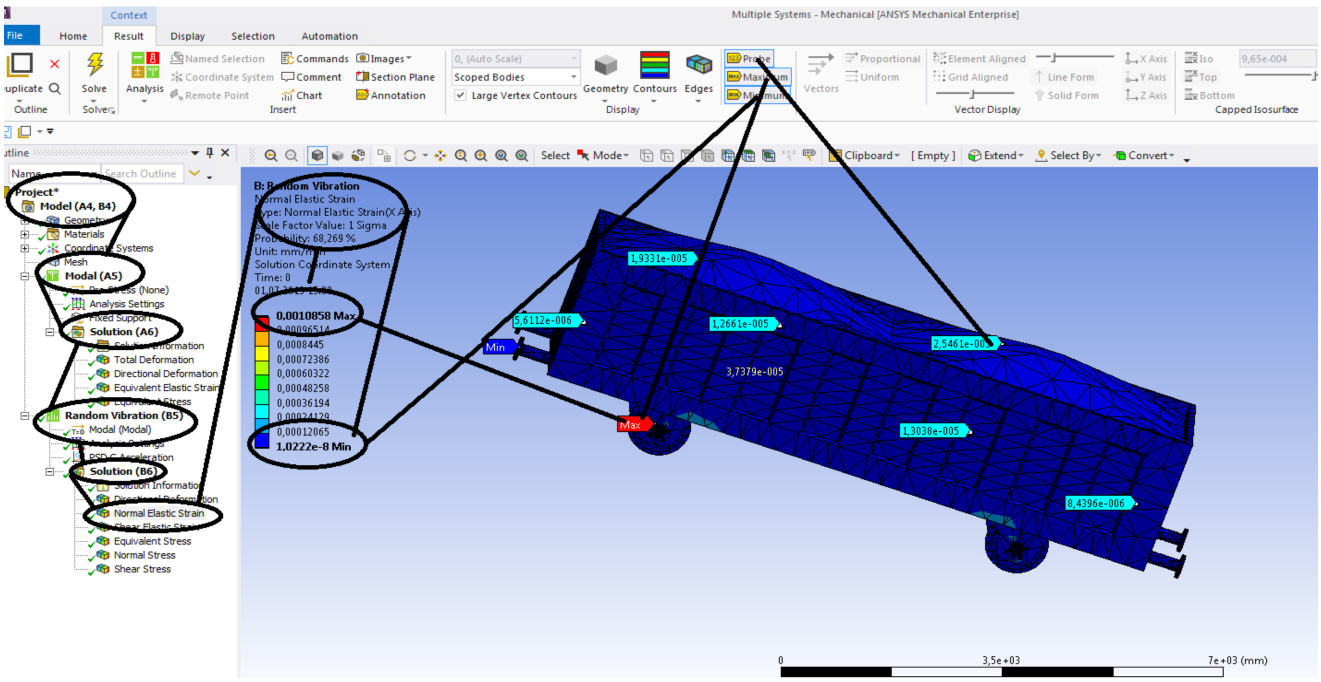


Figura 271 - Deformațiile normale specifice (dupa axa OX) [mm/mm]

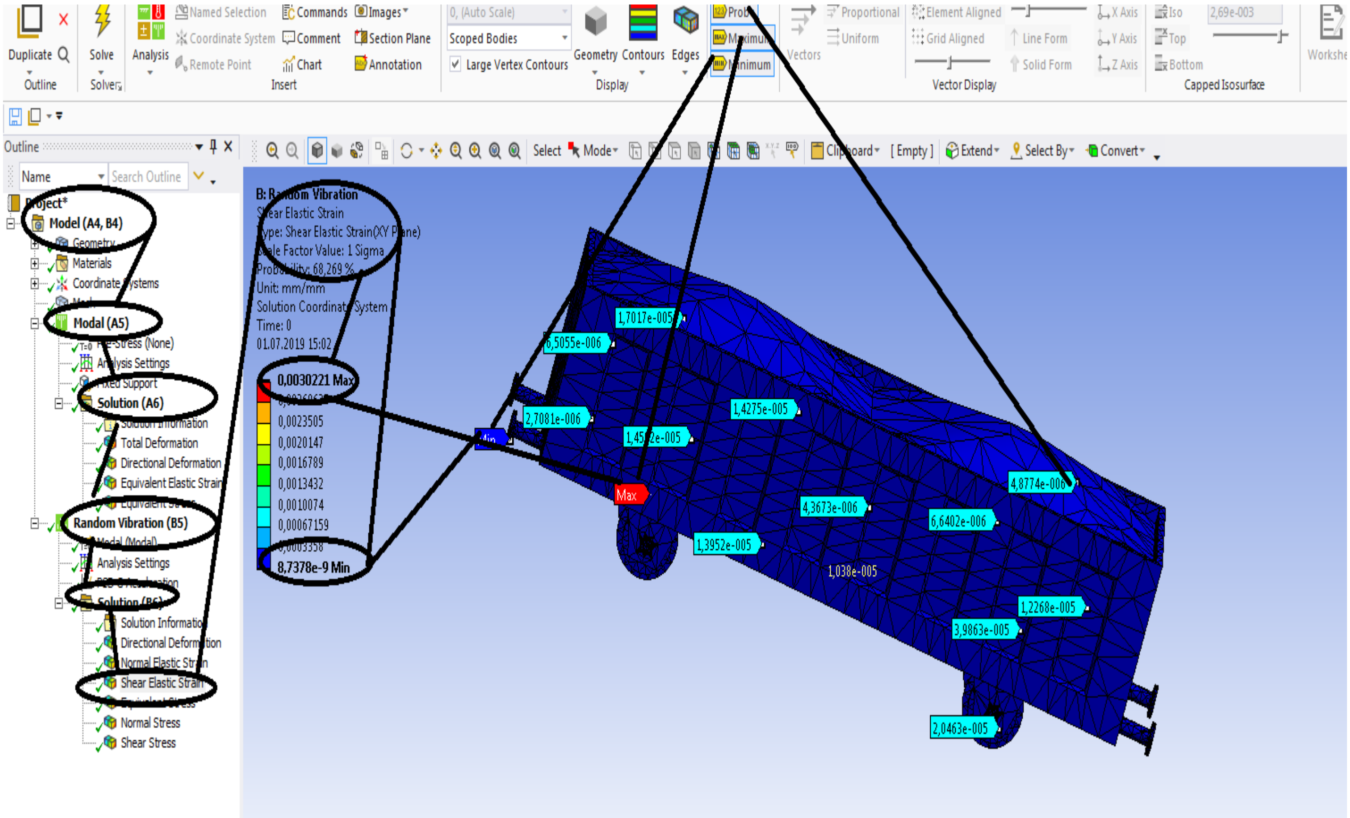


Figura 272 -Lunecarile specifice in planul XOY

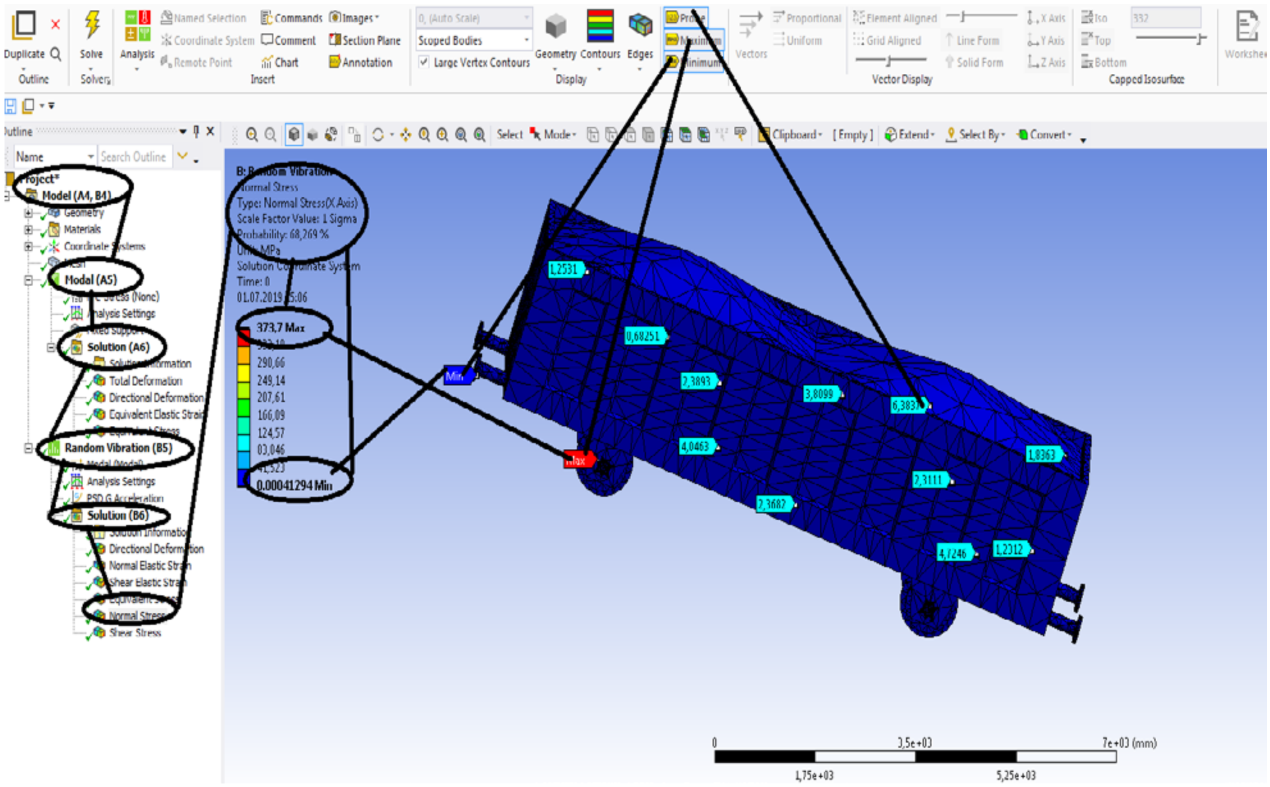


Figura 273 -Tensiuni normale dupa axa OX [MPa]

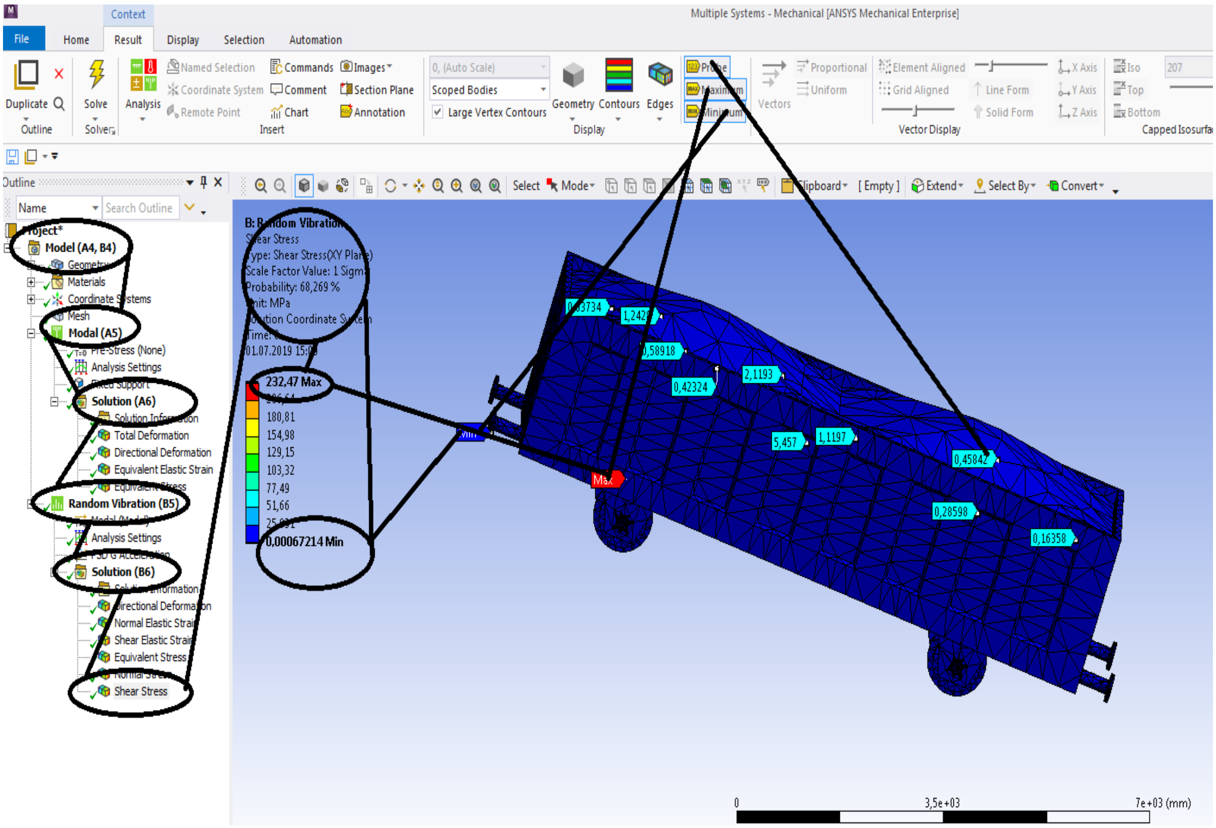


Figura 274 -Tensiuni tangentiale din planul XOY [MPa]

Capitol 5 -Analiza cu elemente finite a rotiilor si a osiei unui vagon de cale ferata

5.1 Static structural mecanic a rotiilor si a osiei unui vagon de cale ferata

-Rezultate

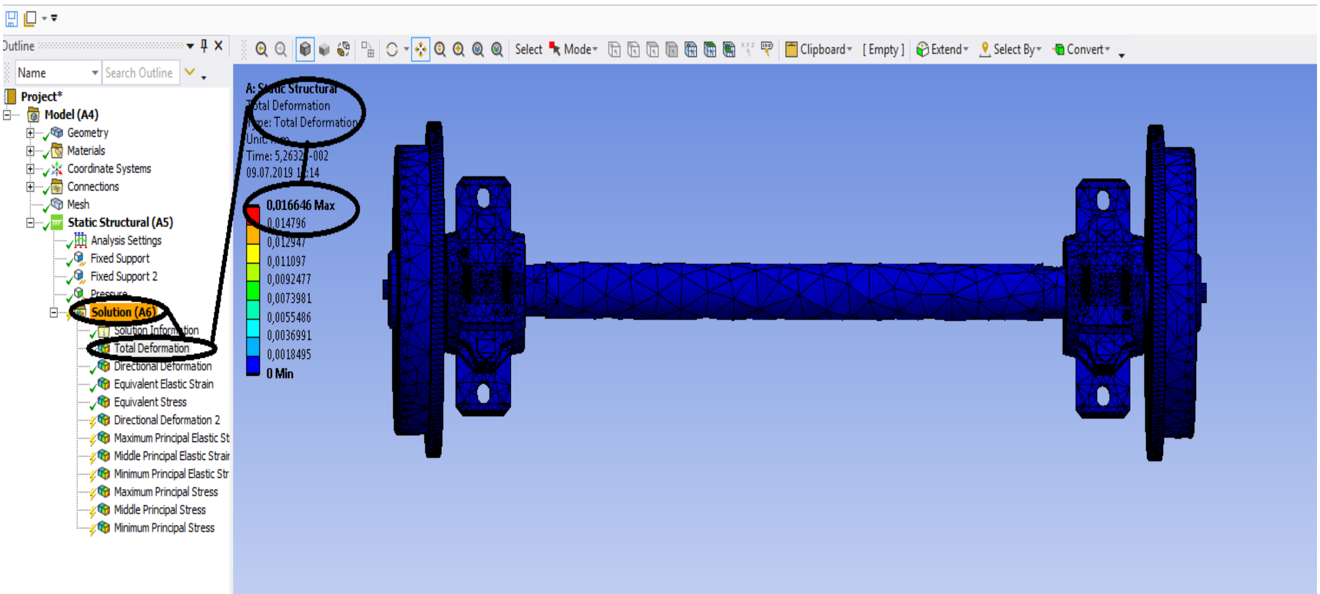


Figura 275 - Deformații totale [mm]

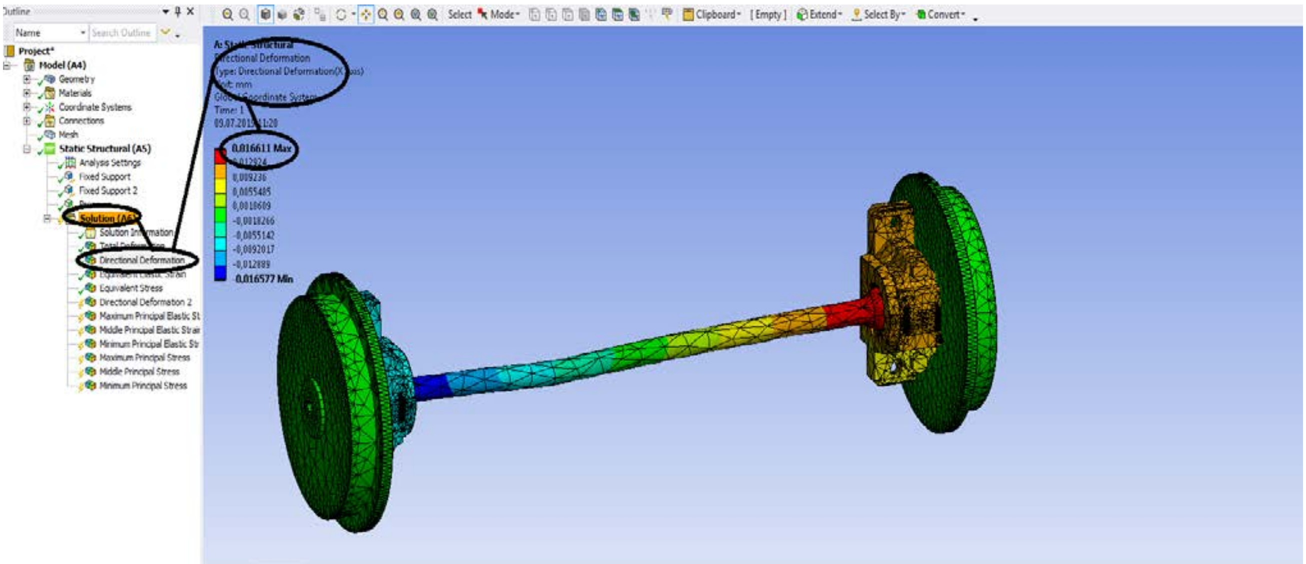


Figura 276 - Deformații direcționale pe axa x [mm]

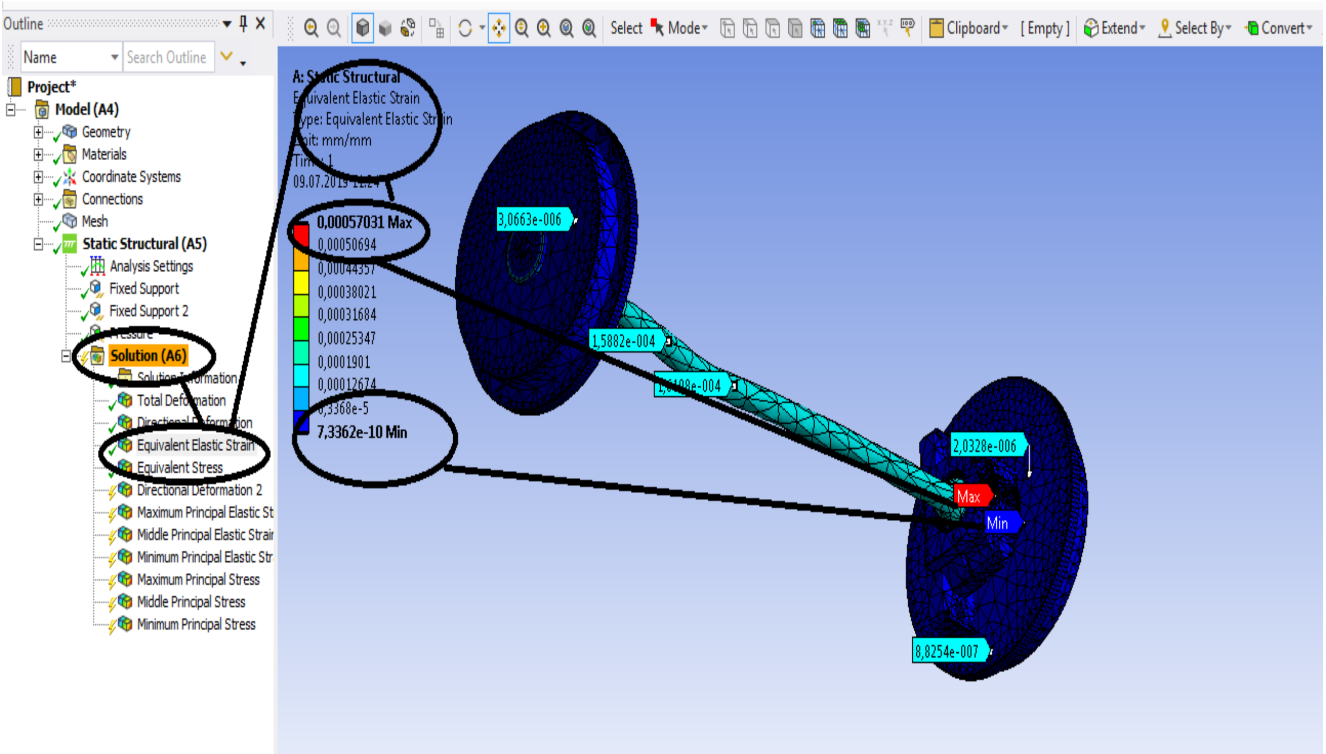


Figura 277 - Deformațiile specifice echivalente ε [mm/mm]

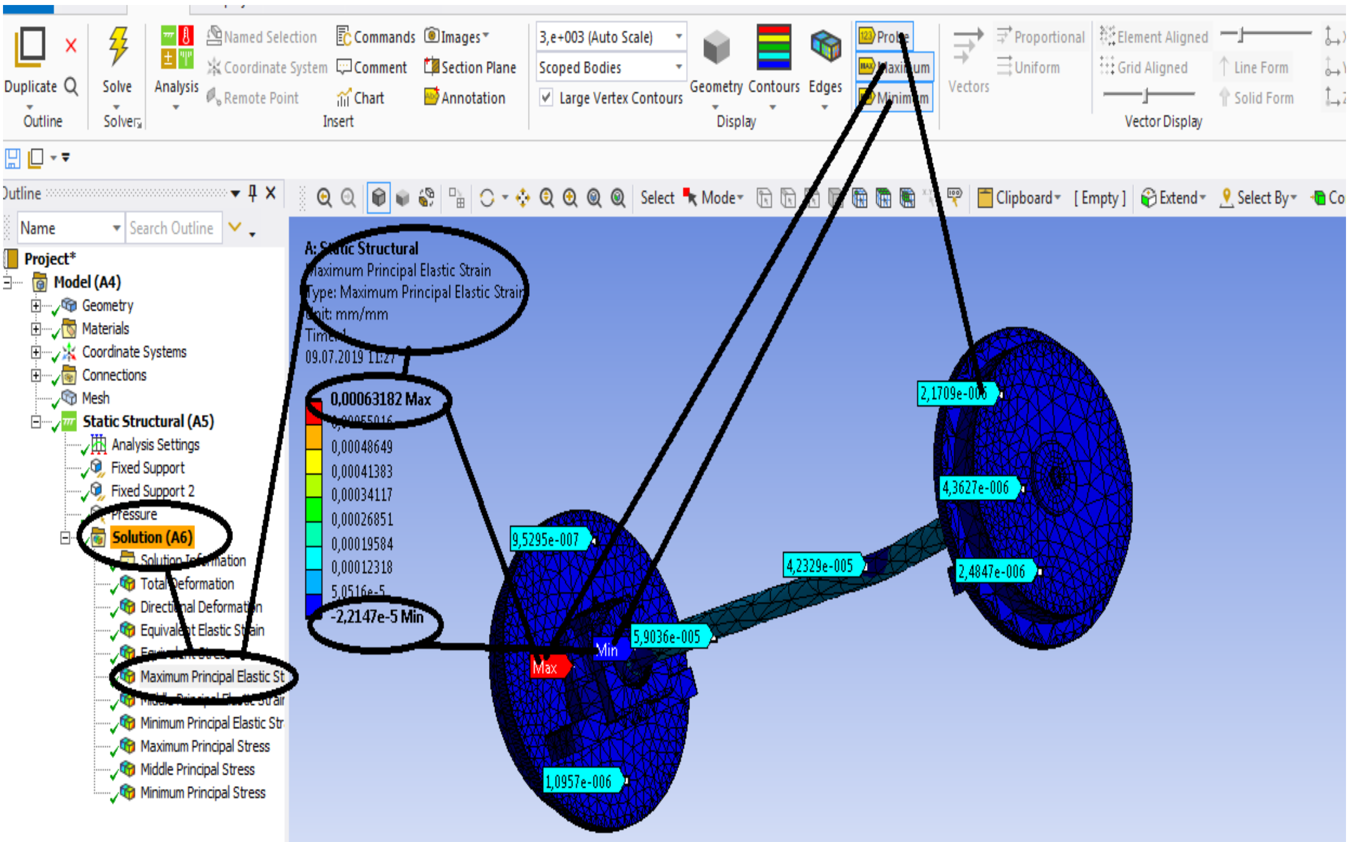


Figura 278 - Deformațiile specifice principale - ε1 [mm/mm]

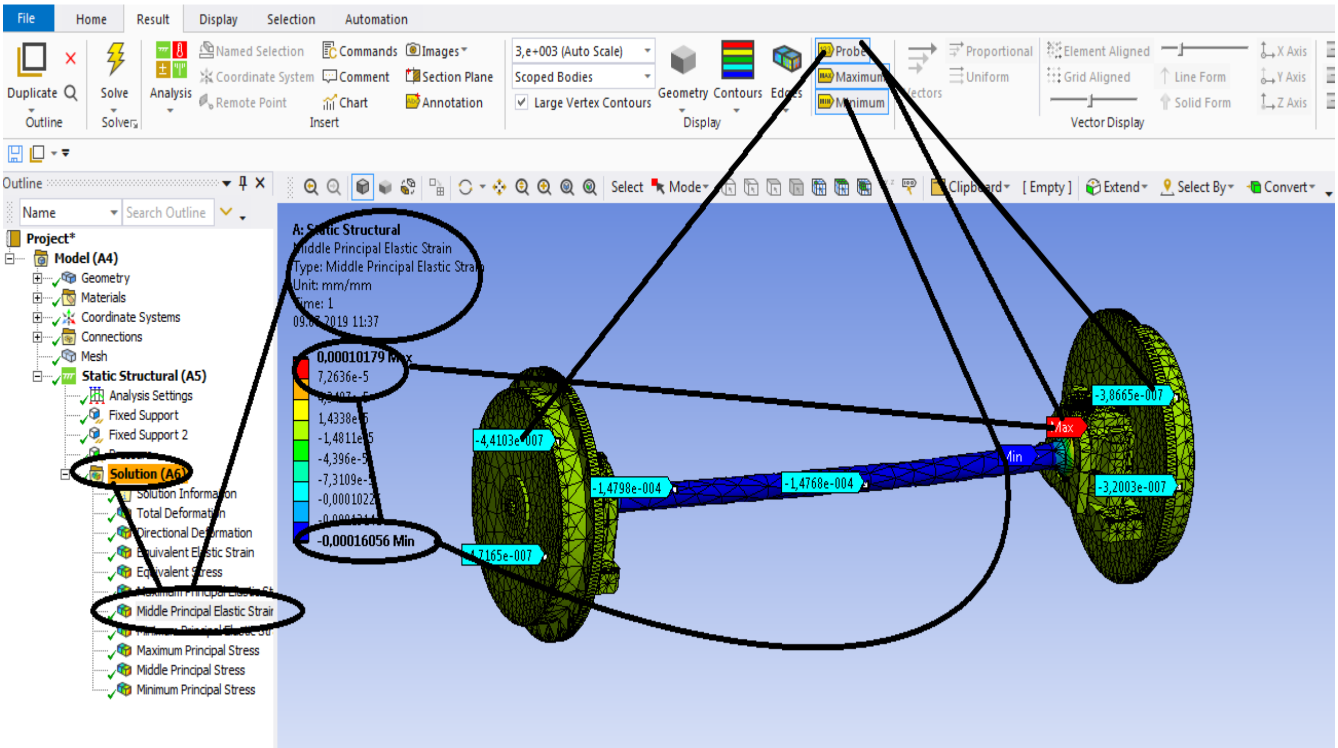


Figura 279 - Deformațiile specifice principale ε2 [mm/mm]

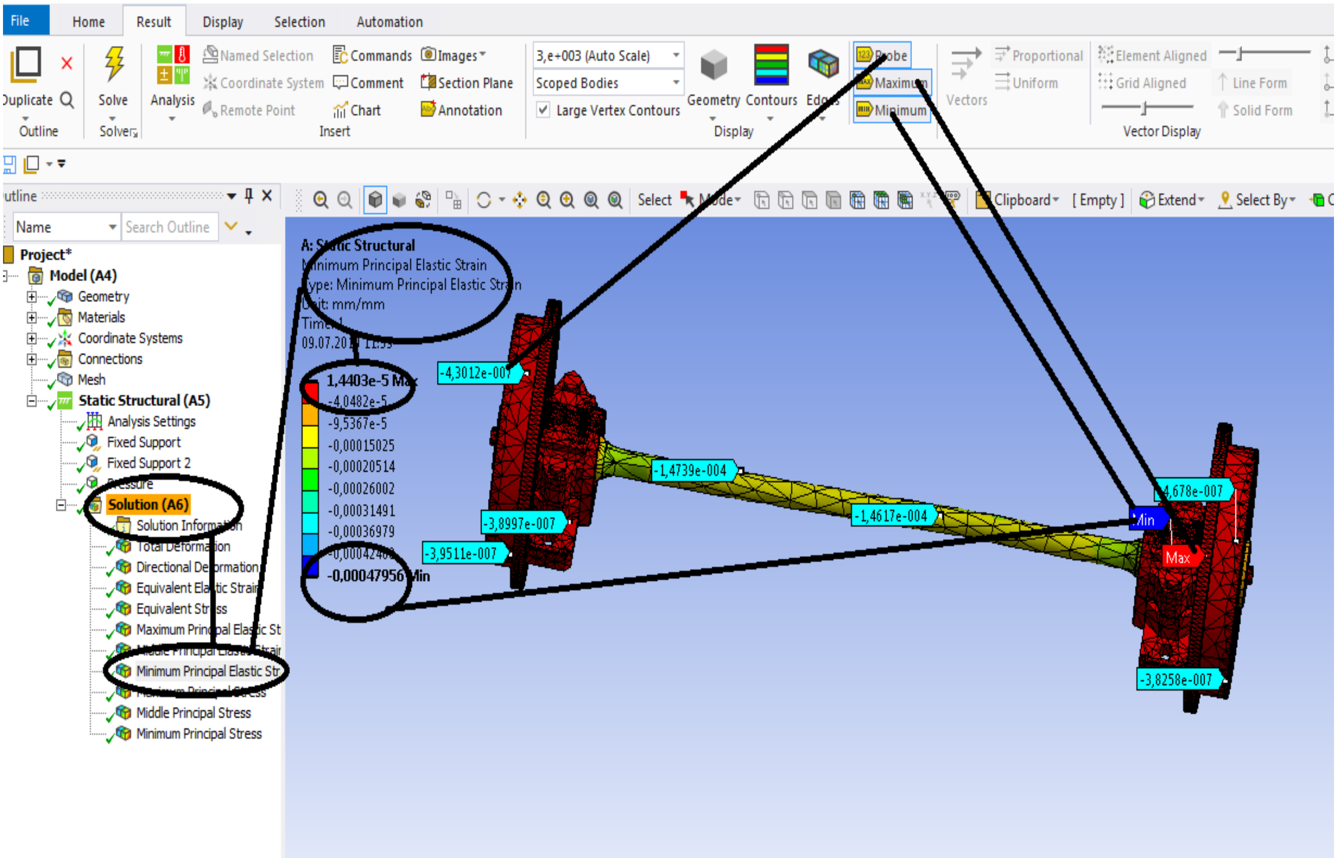


Figura 280 - Deformațiile specifice principale ε3 [mm/mm]

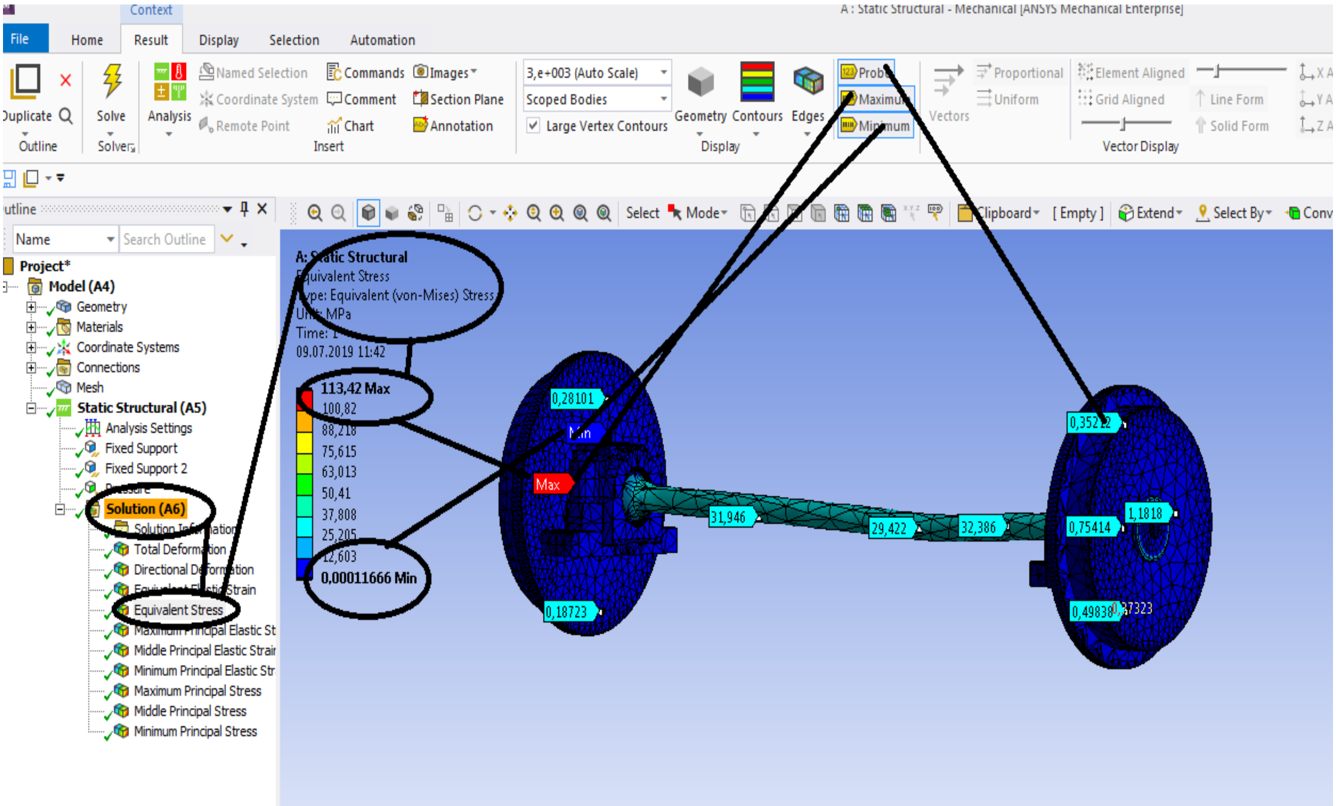


Figura 281 - Tensiunile echivalente von Mises [MPa]

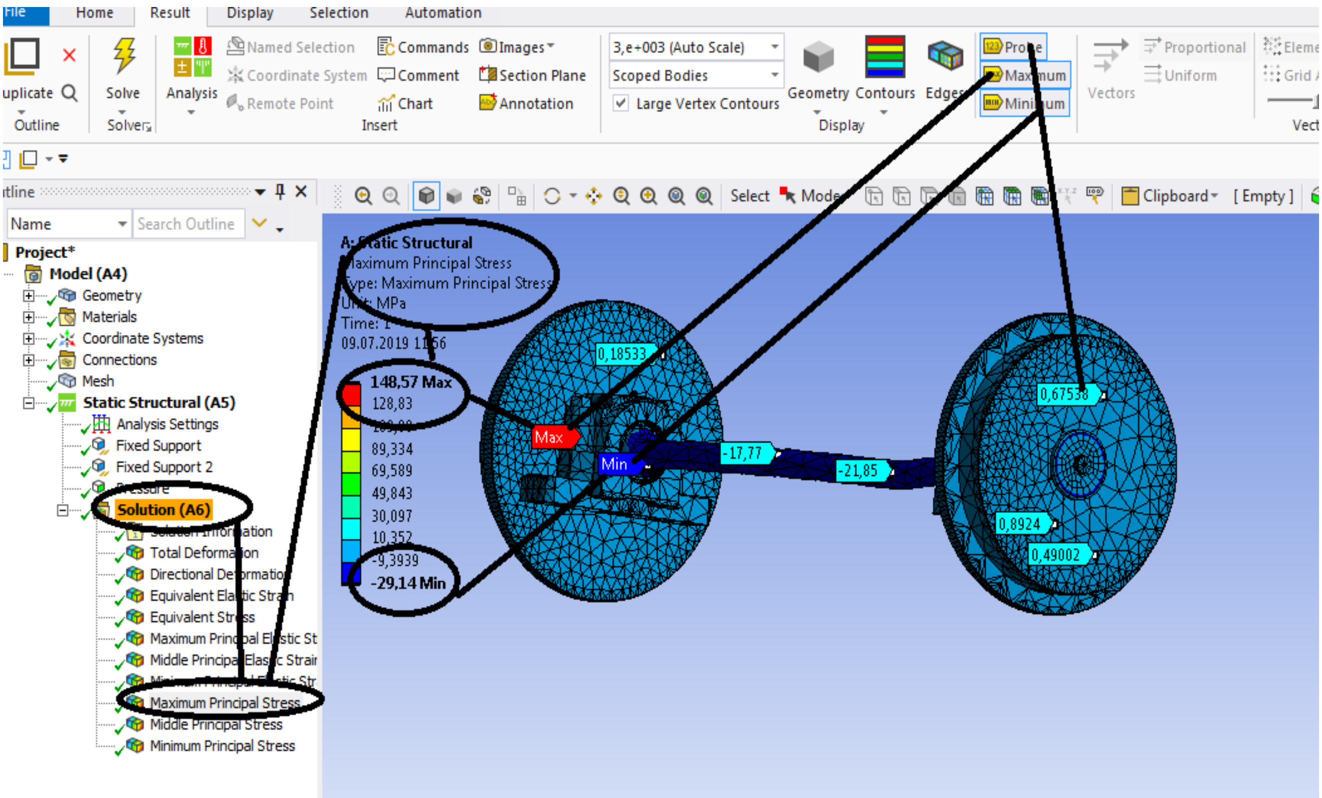


Figura 282 - Tensiunile principale $\sigma 1$ [MPa]

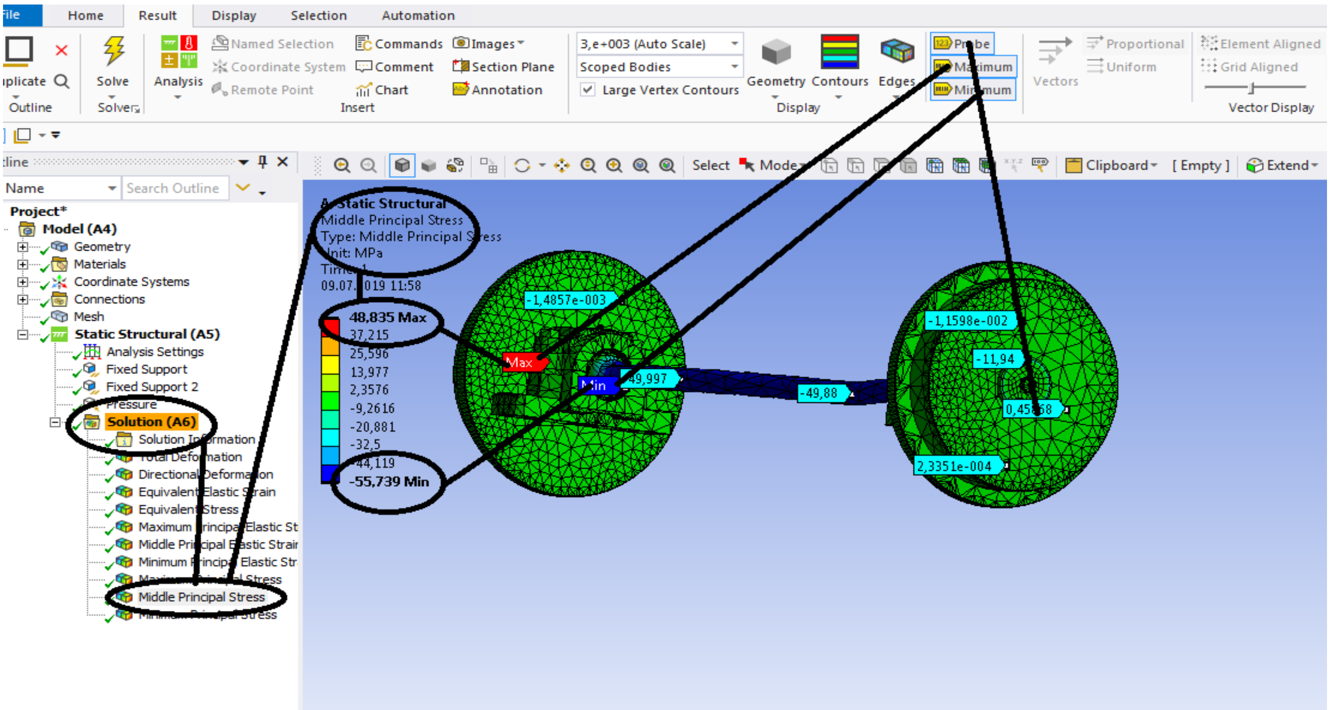


Figura 283 - Tensiunile principale $\sigma 2$ [MPa]

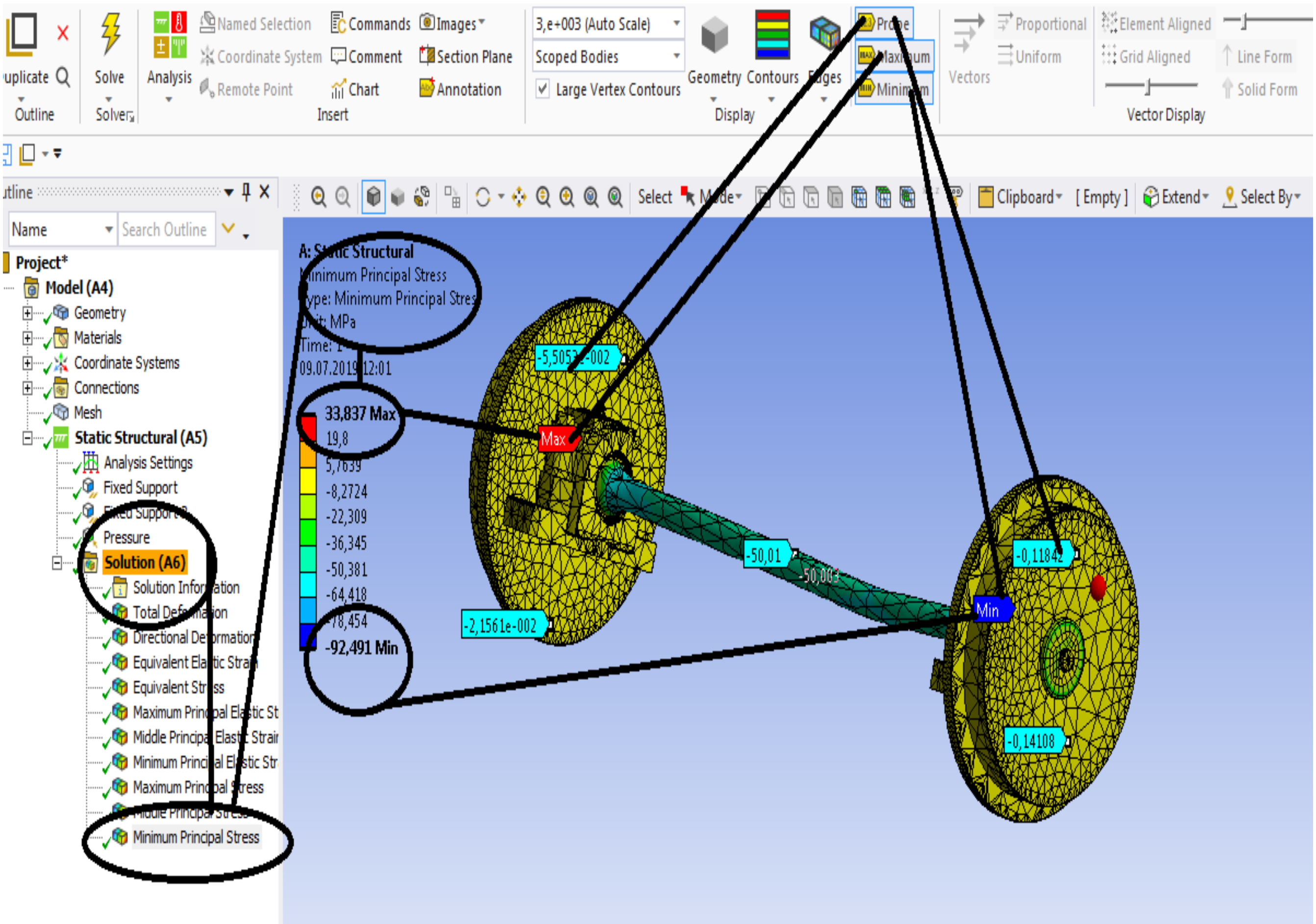


Figura 284 -Tensiunile principale $\sigma 3$ [MPa]

5.2 Static structural termic a rotiilor si a osiei unui vagon de cale ferata

-Rezultate

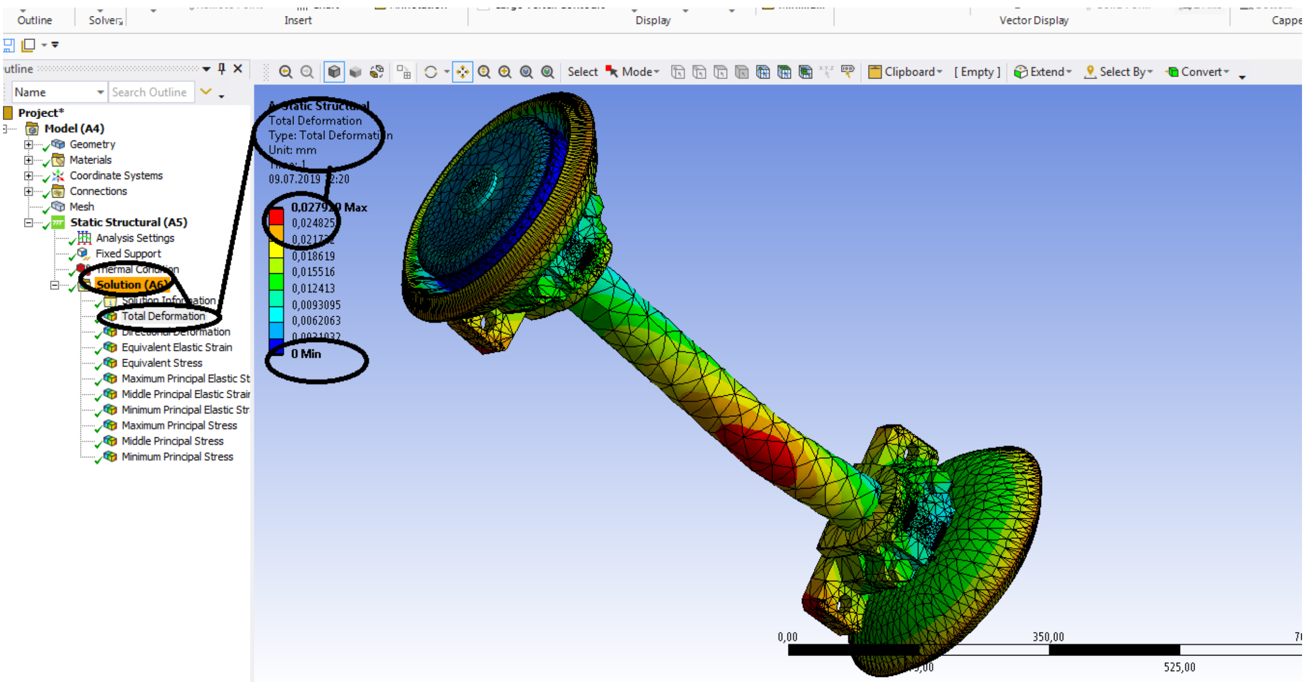


Figura 285 - Deformații totale [mm]

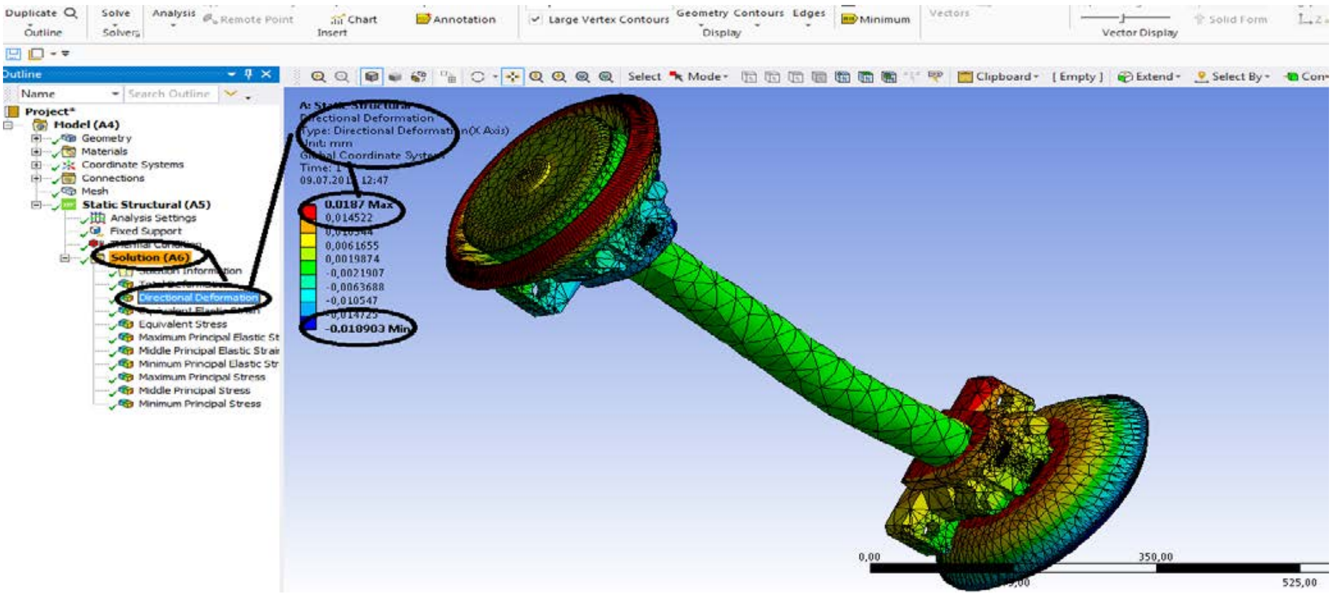


Figura 286 - Deformații direcționale pe axa x [mm]

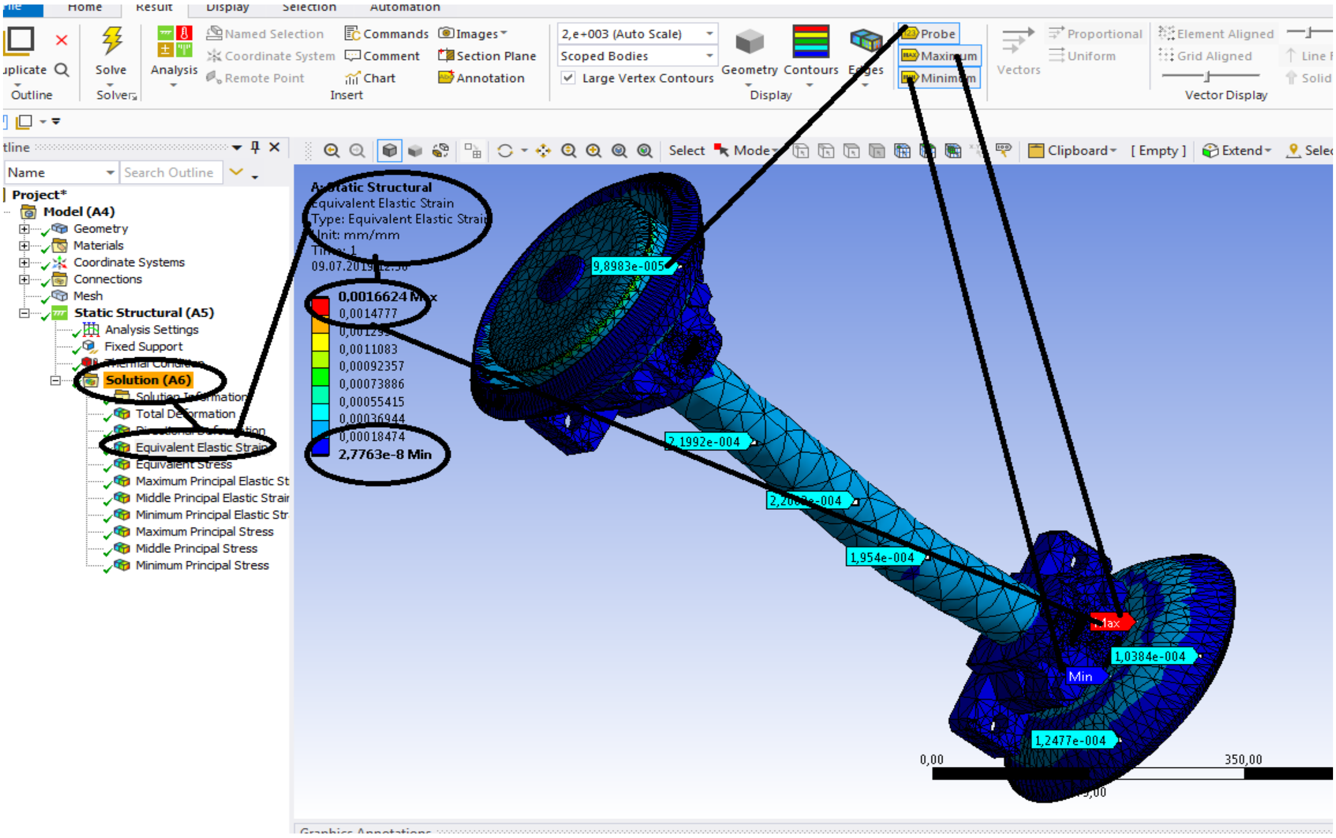


Figura 287 - Deformațiile specifice echivalente ε [mm/mm]

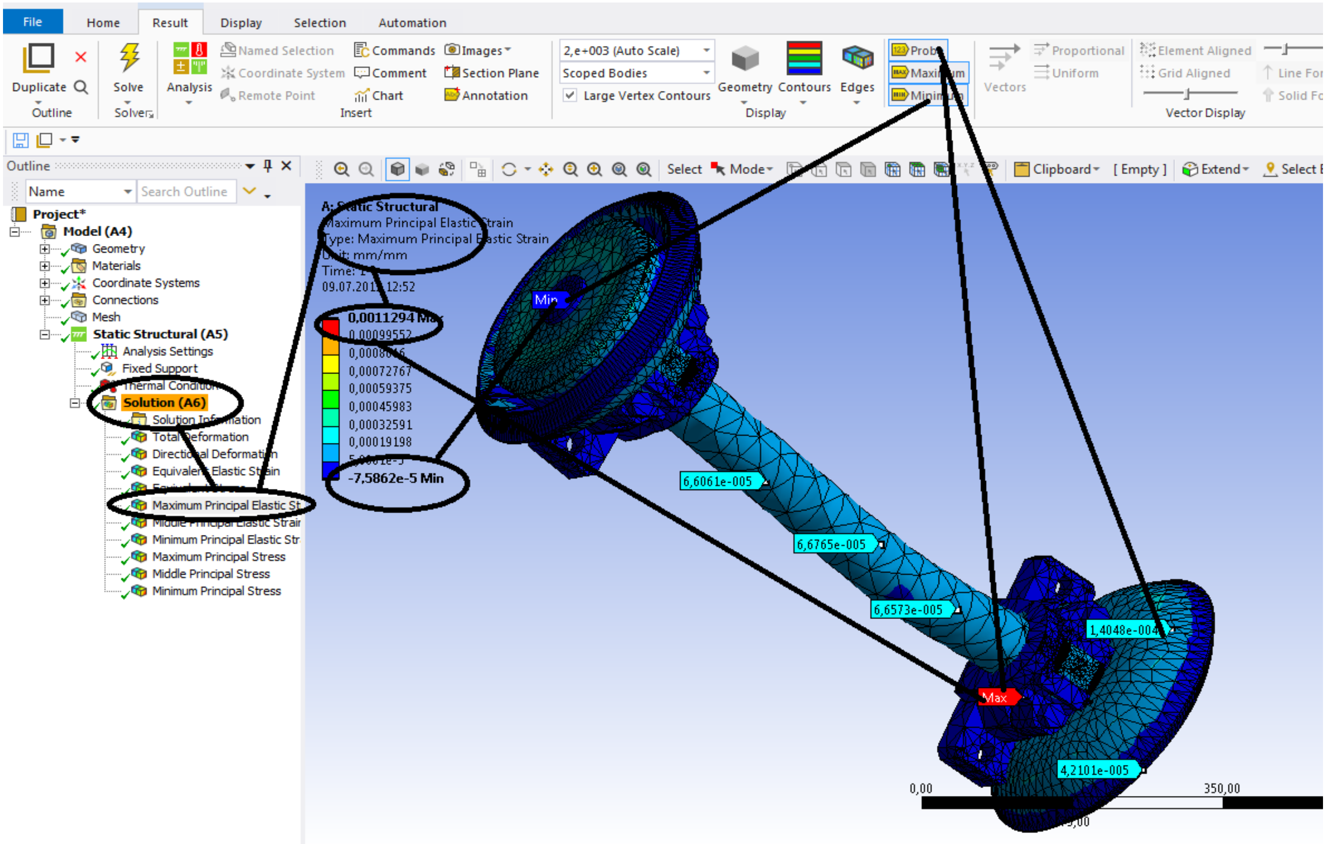


Figura 288 - Deformațiile specifice principale - ε1 [mm/mm]

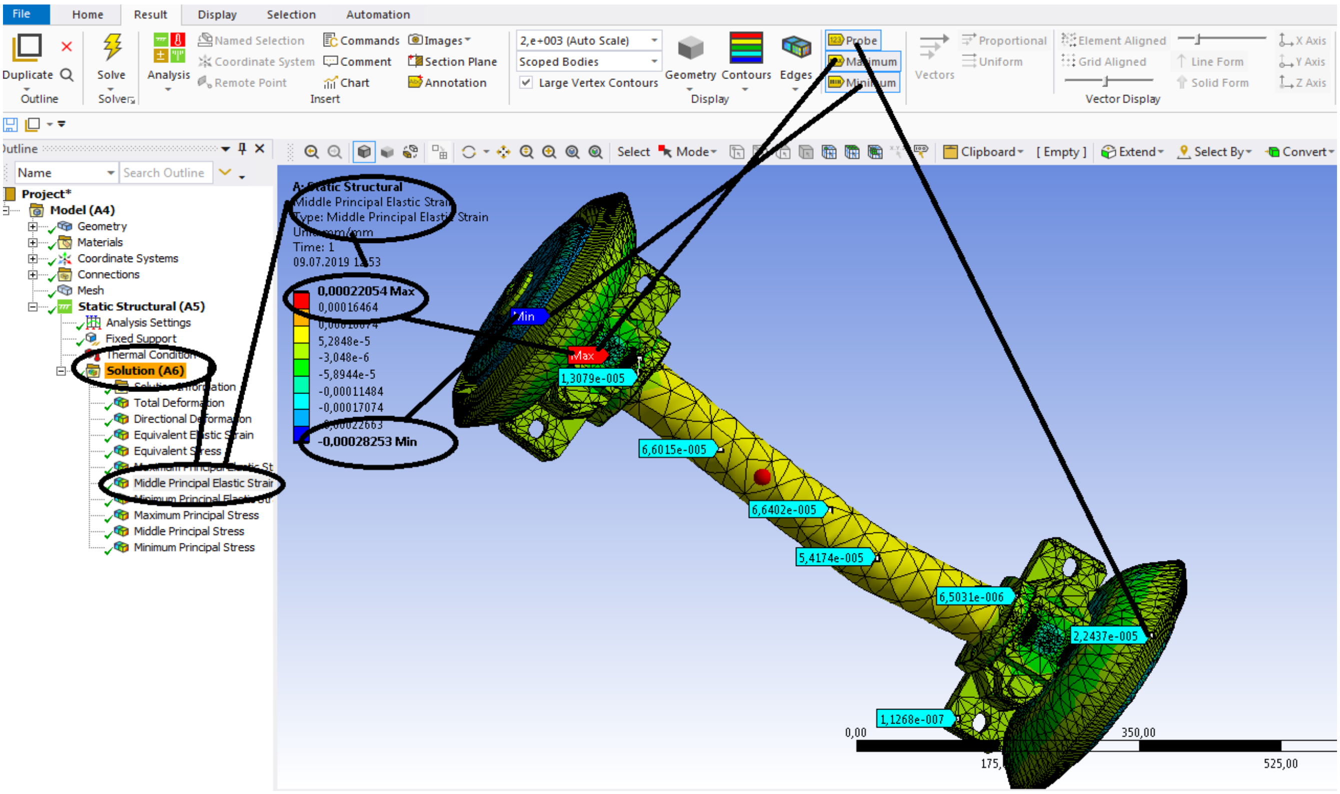


Figura 289 - Deformațiile specifice principale ε2 [mm/mm]

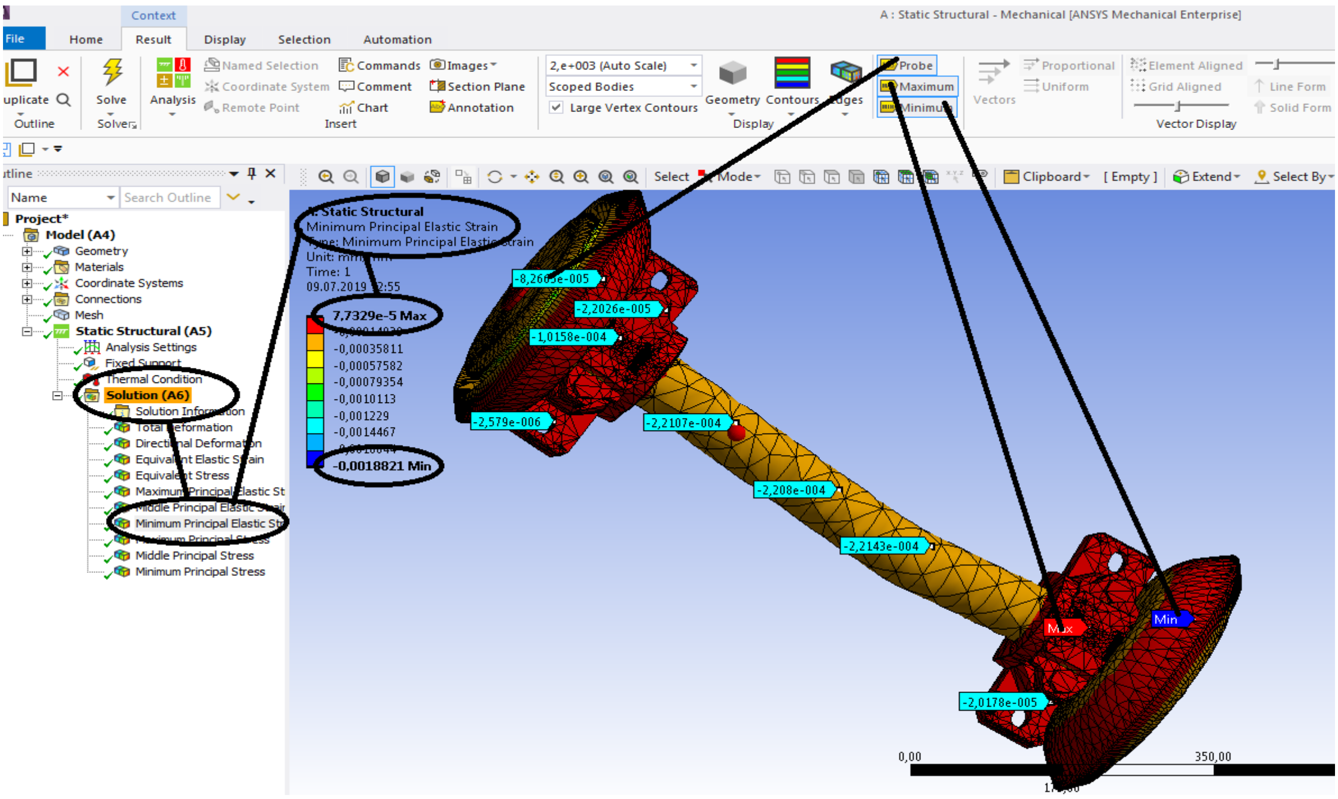


Figura 290 - Deformațiile specifice principale ε3   [mm/mm]

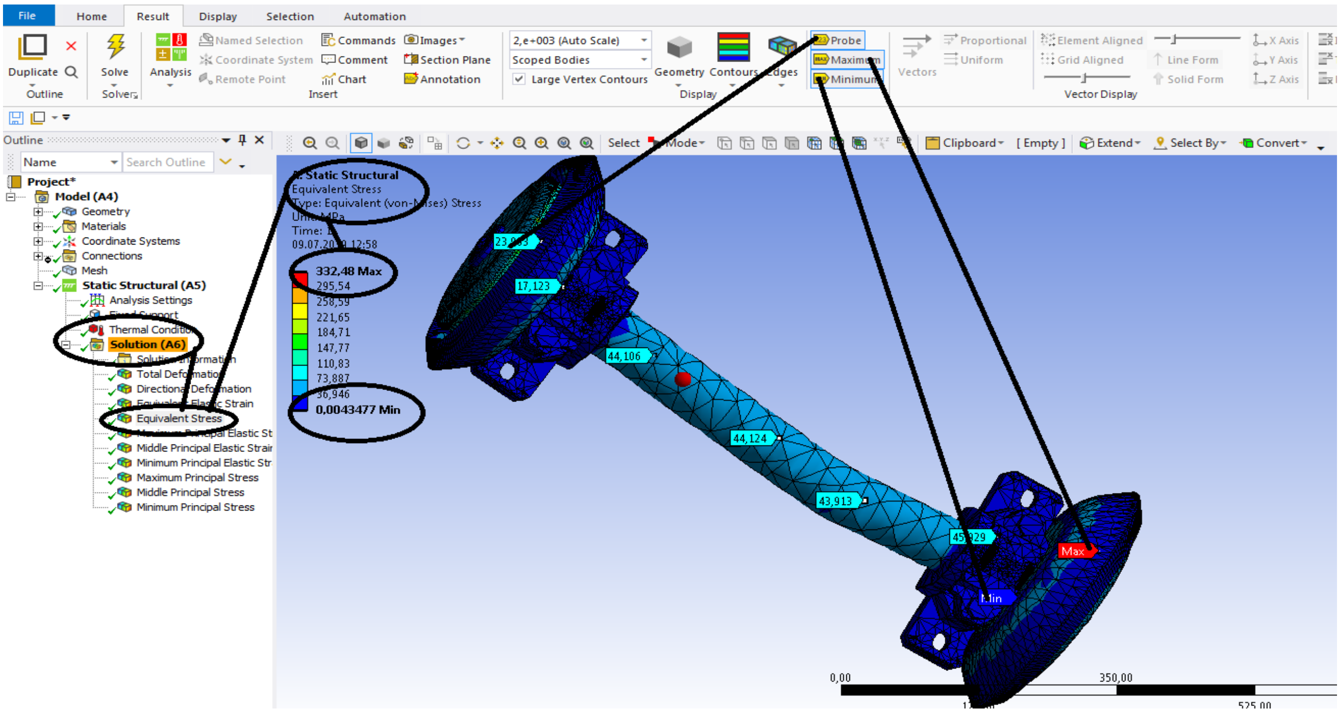


Figura 291 - Tensiunile echivalente von Mises [MPa]

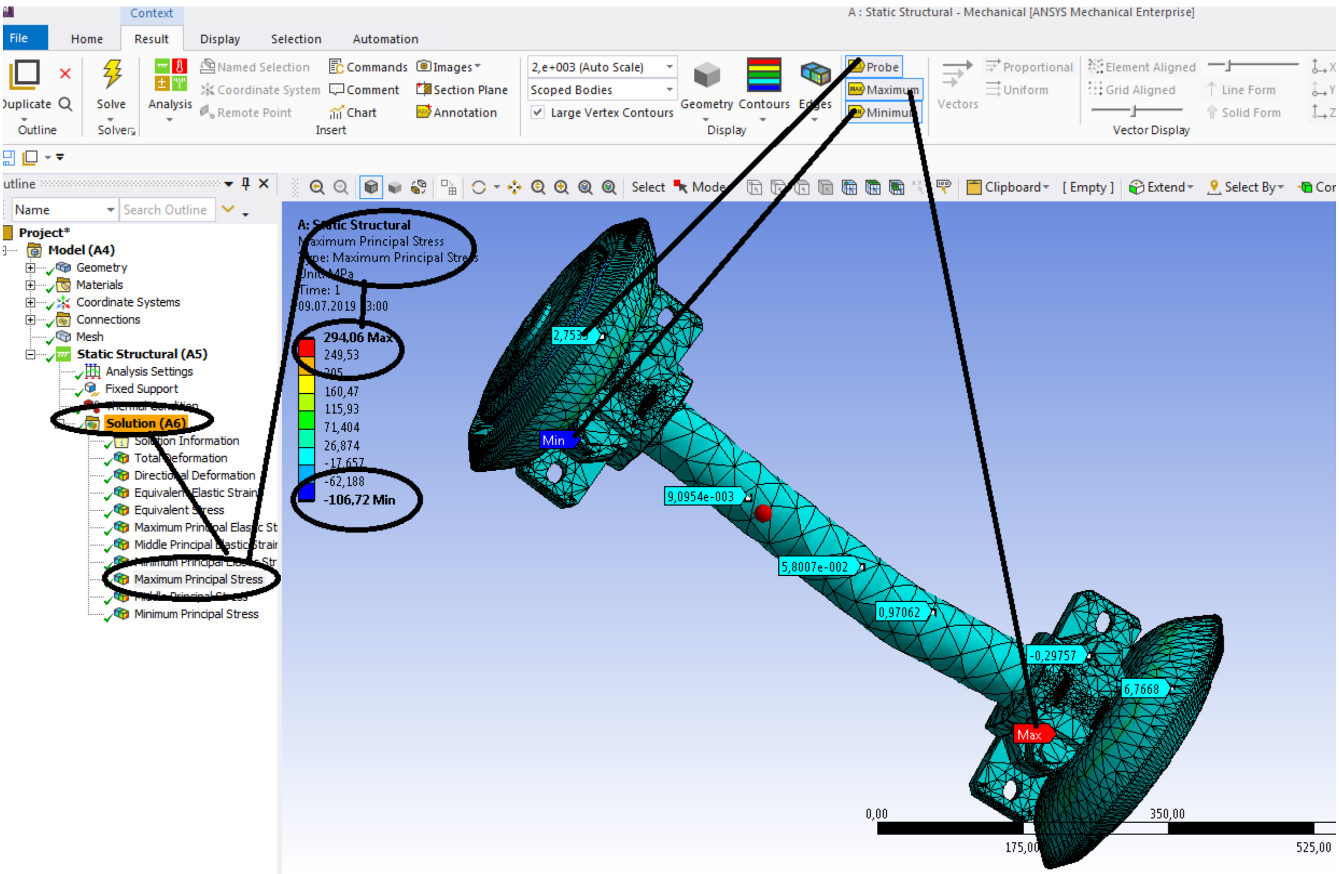


Figura 292 - Tensiunile principale $\sigma 1$ [MPa]

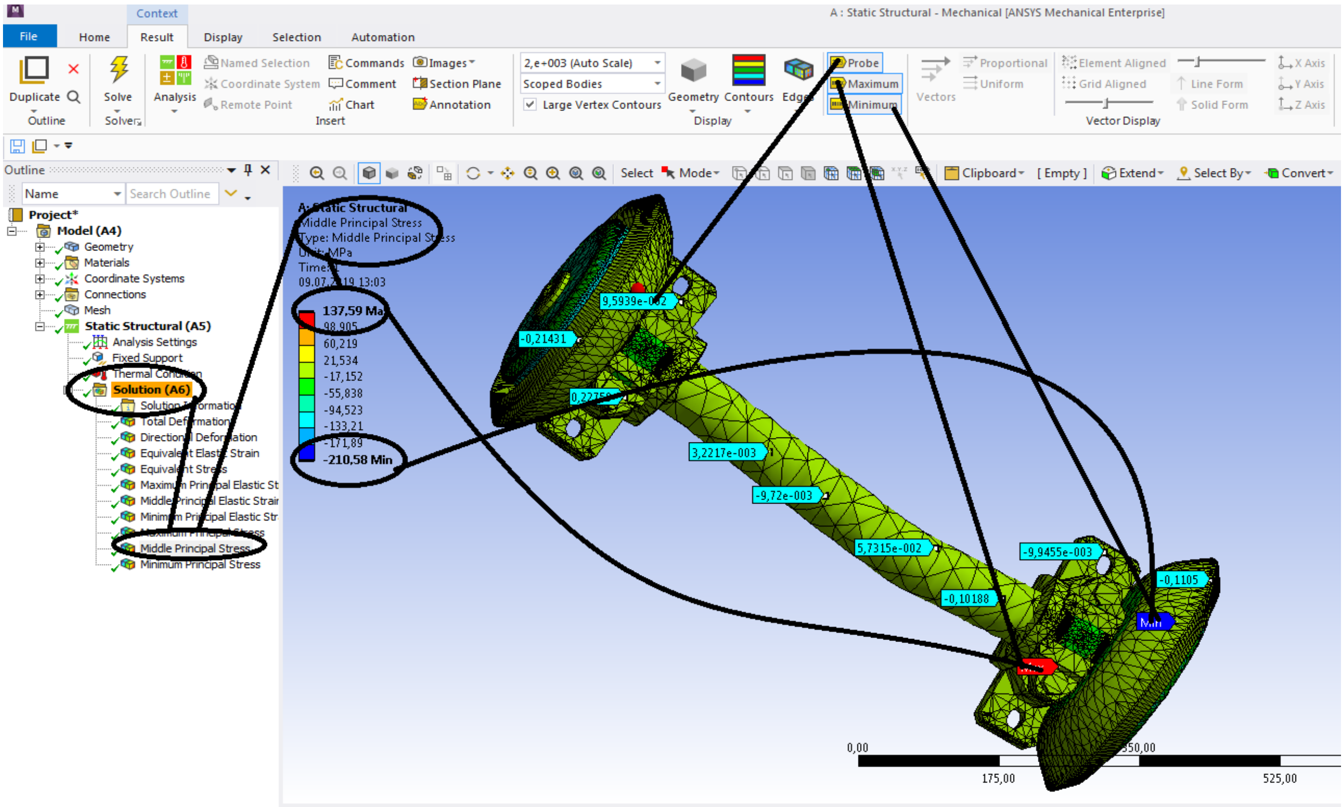


Figura 293 - Tensiunile principale $\sigma 2$ [MPa]

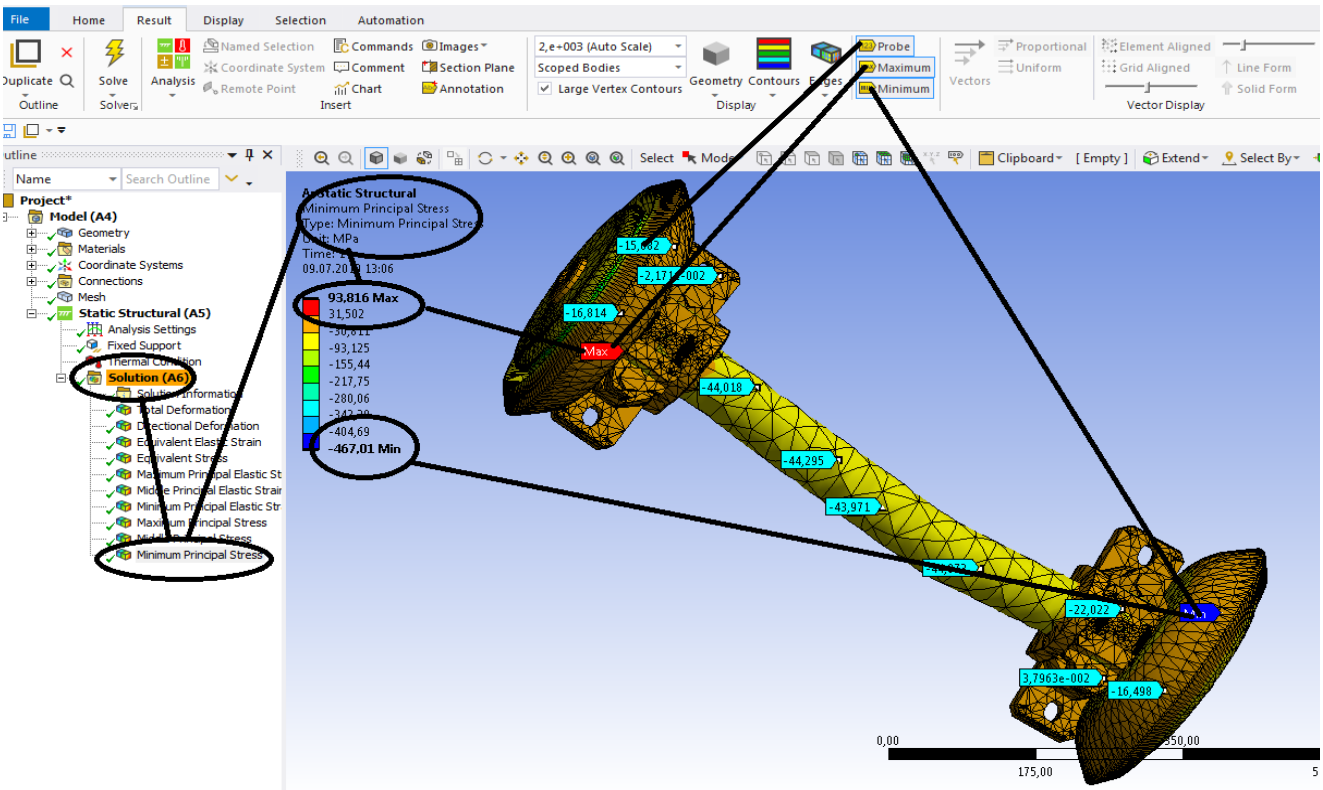


Figura 294 -Tensiunile principale $\sigma 3$ [MPa]

5.3 Static structural mecanic si termic a rotiilor si a osiei unui vagon de cale ferata

-Rezultate

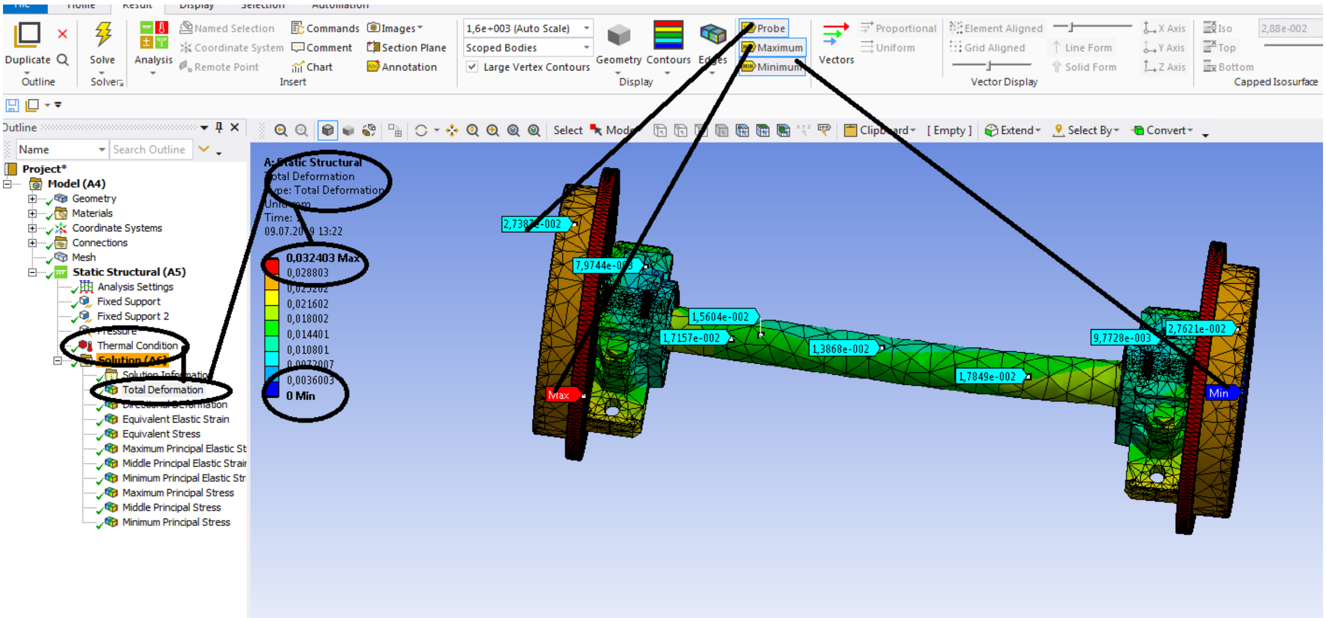


Figura 295 - Deformații totale [mm]

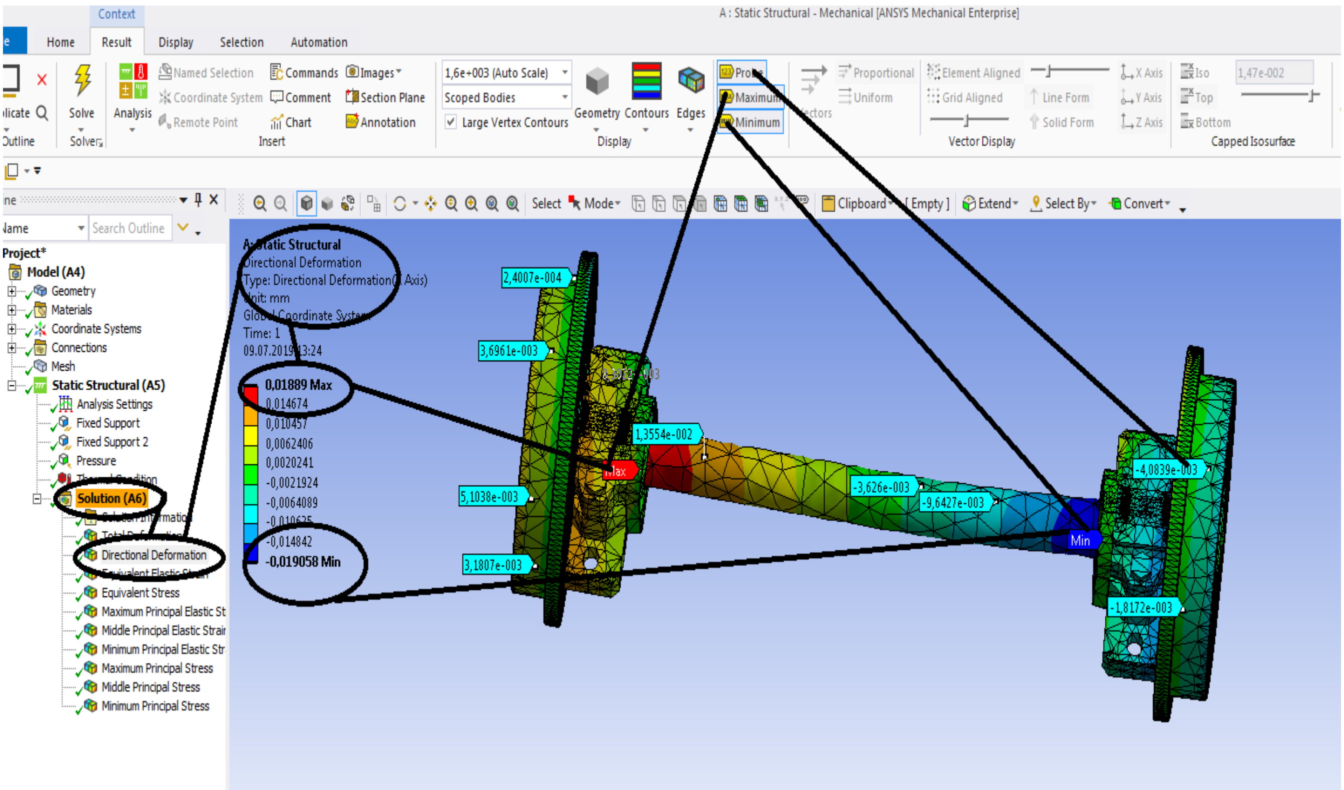


Figura 296 - Deformații direcționale pe axa x [mm]

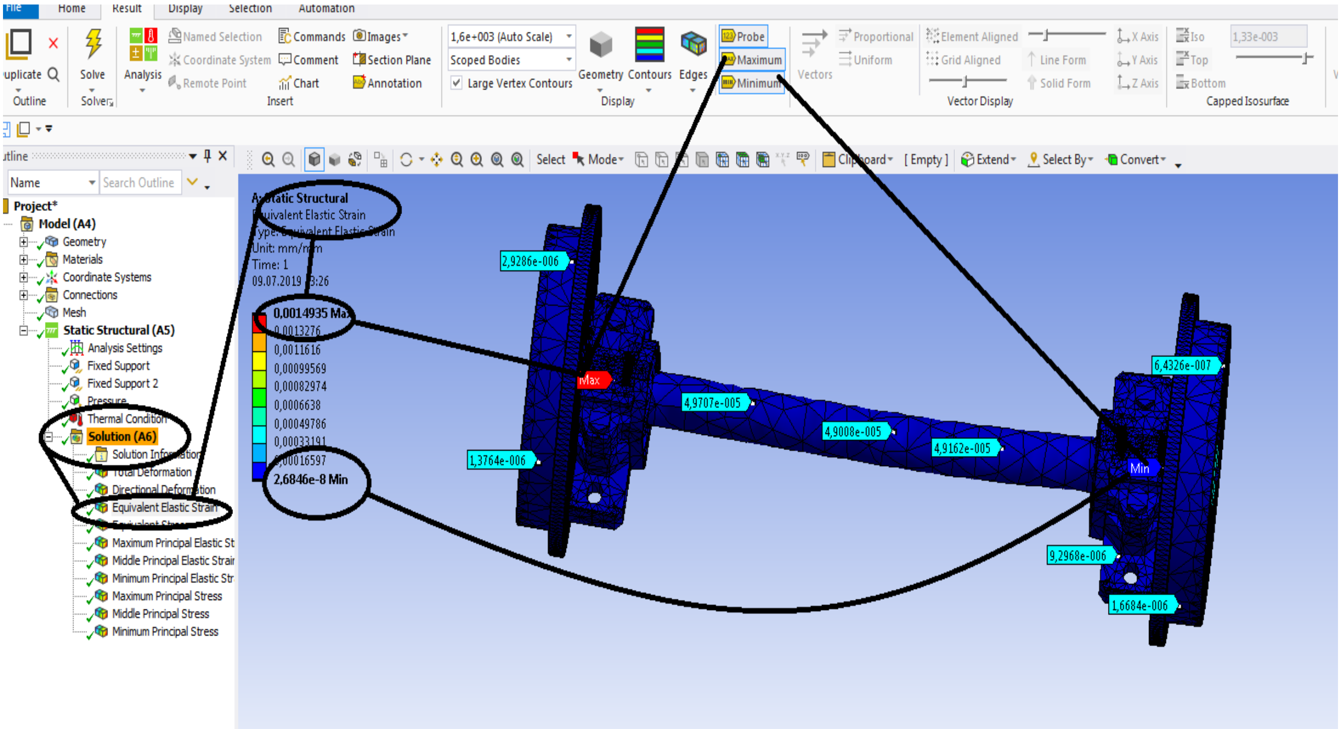


Figura 297 - Deformațiile specifice echivalente ε [mm/mm]

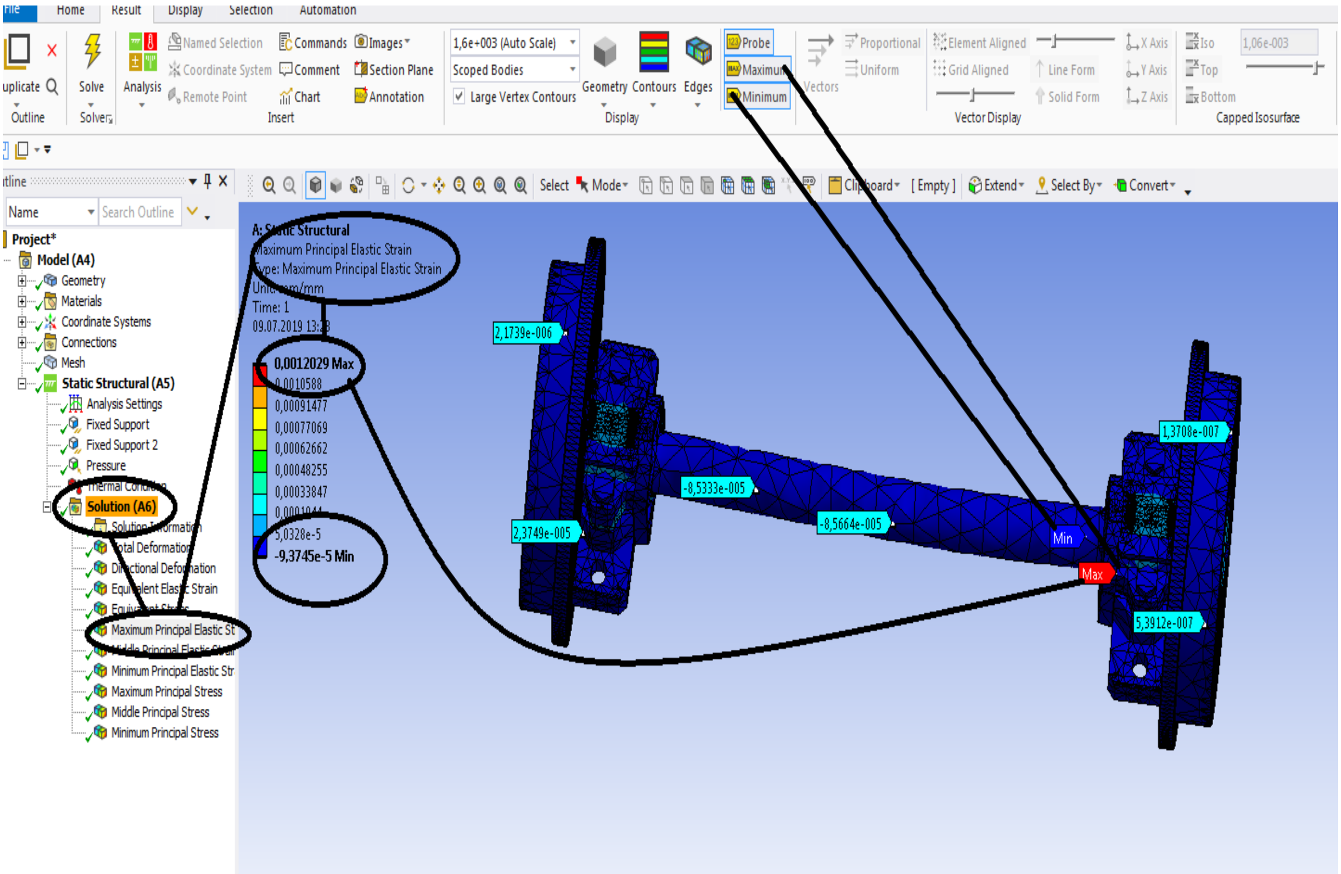


Figura 298 - Deformațiile specifice principale - ε1 [mm/mm]

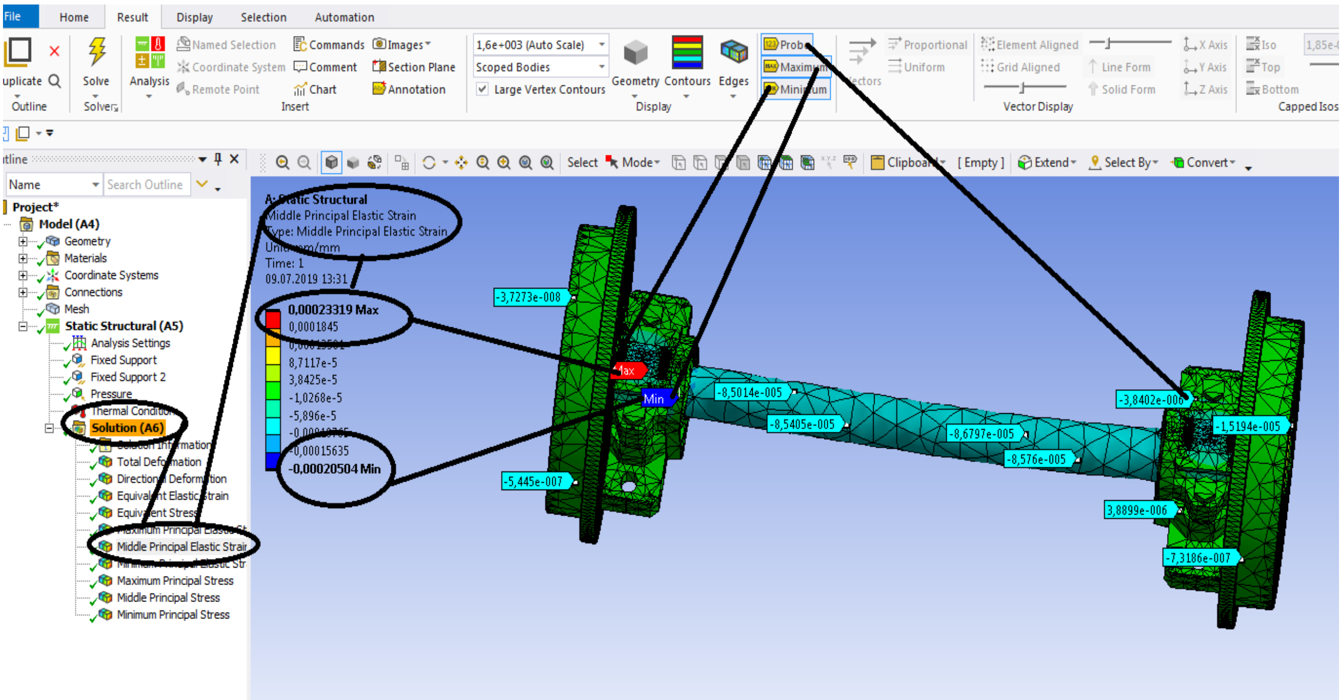


Figura 299 - Deformațiile specifice principale ε2 [mm/mm]

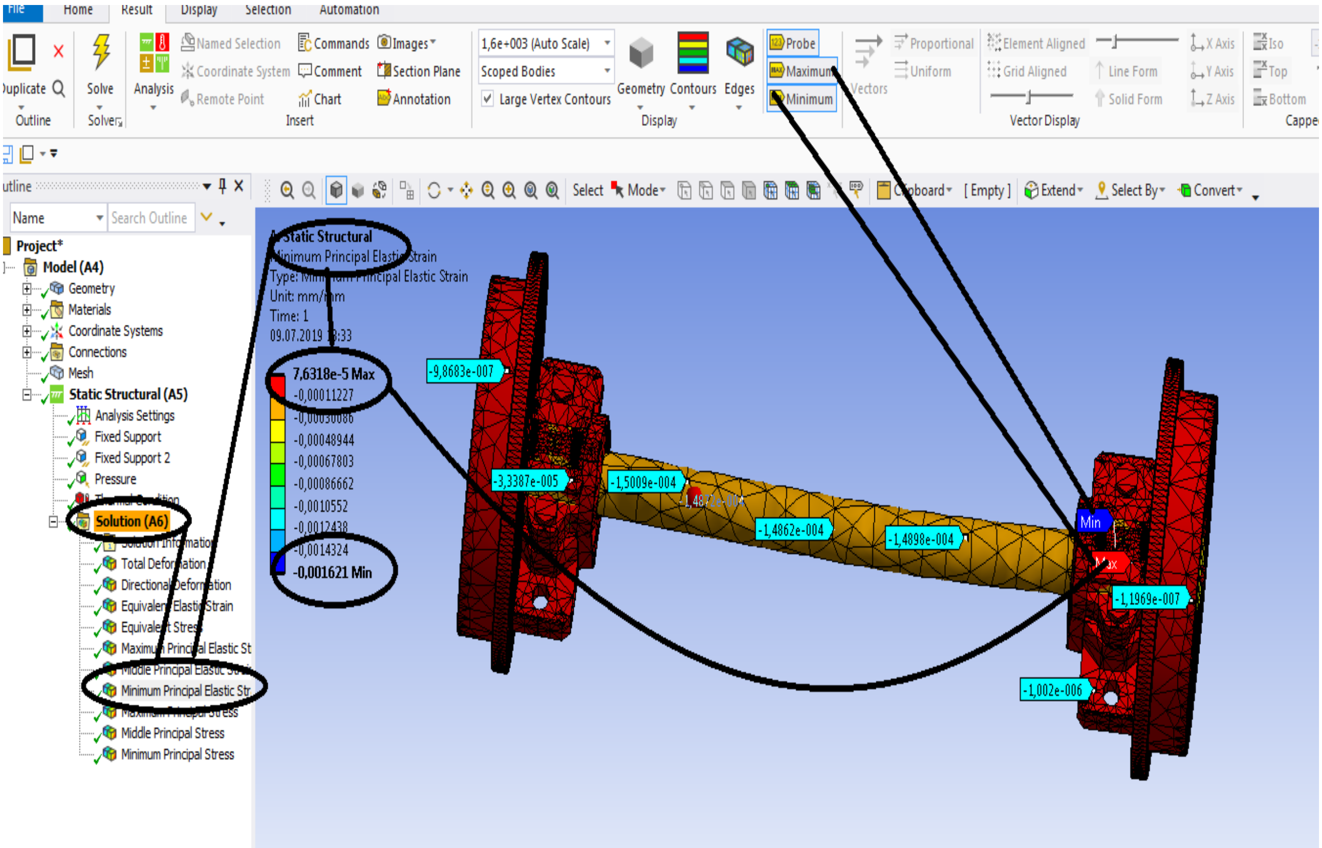


Figura 300 - Deformațiile specifice principale ε3 [mm/mm]

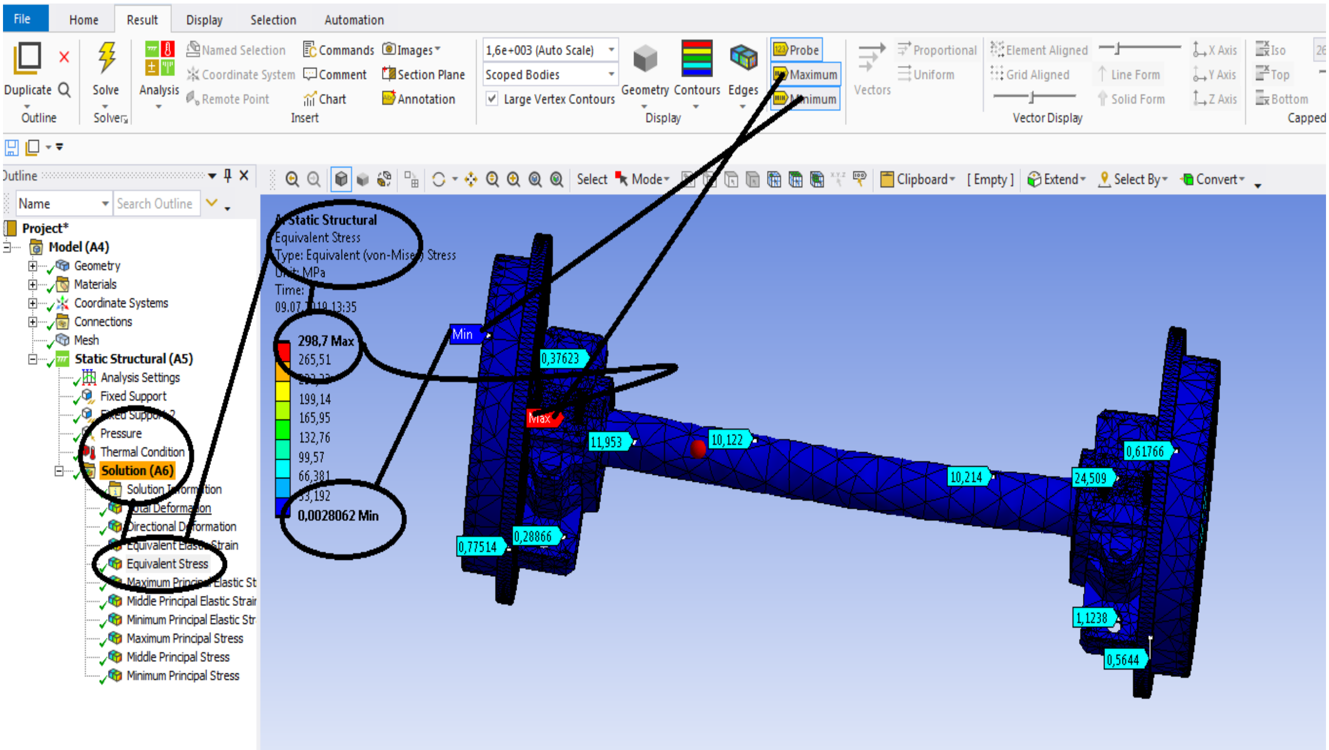


Figura 301 - Tensiunile echivalente von Mises [MPa]

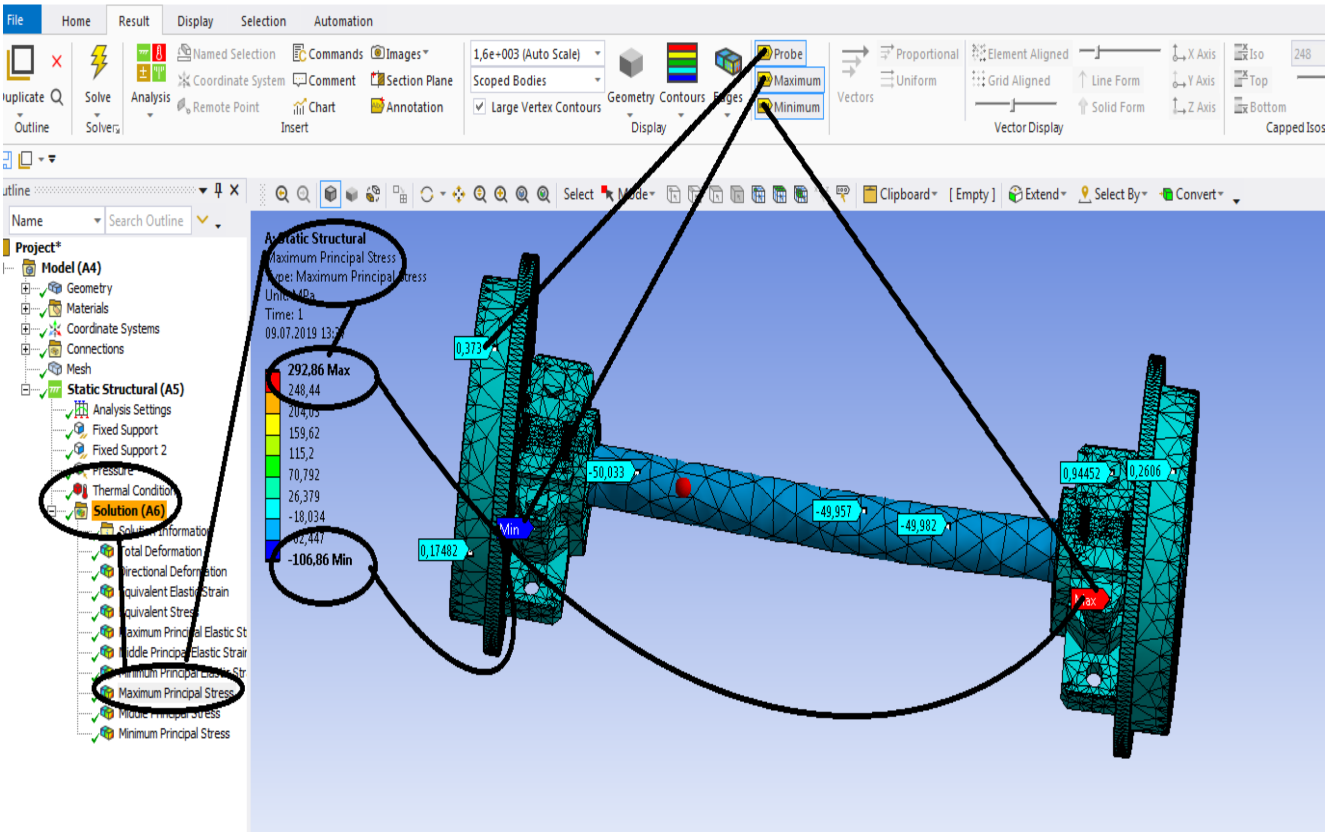


Figura 302 - Tensiunile principale $\sigma 1$ [MPa]

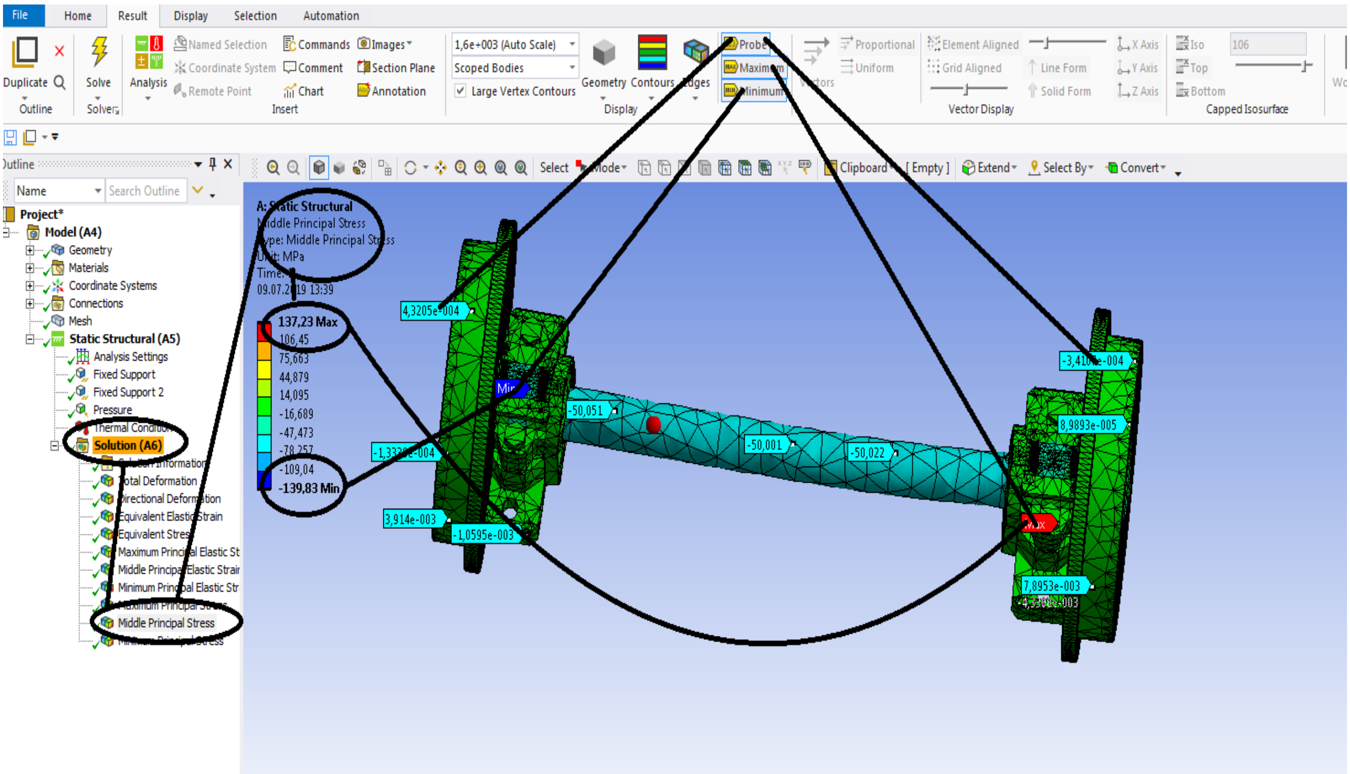


Figura 303 - Tensiunile principale $\sigma 2$ [MPa]

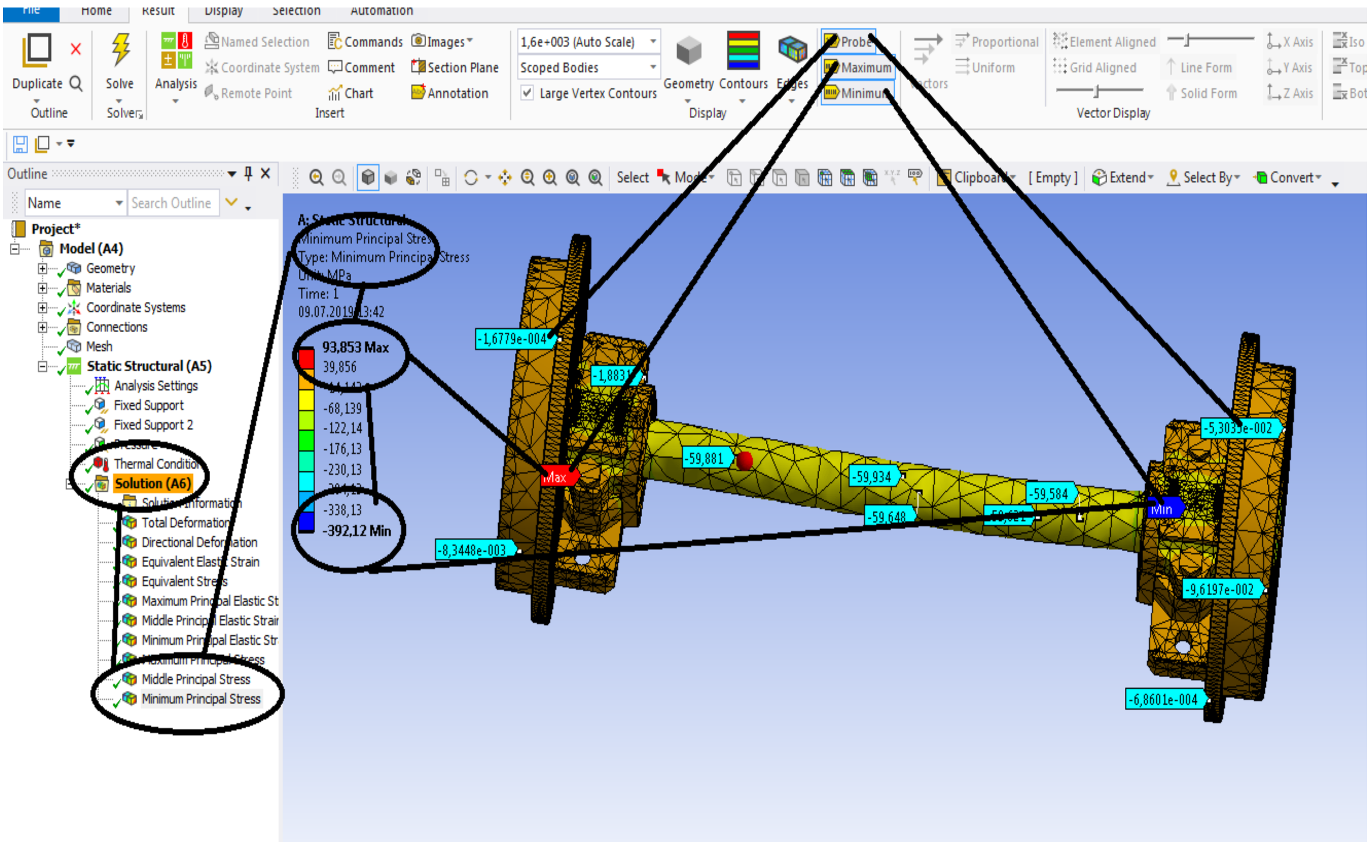


Figura 304 -Tensiunile principale $\sigma 3$ [MPa]

5.4 Solicitarea la oboseala a rotiilor si a osiei unui vagon de cale ferata

-Rezultate

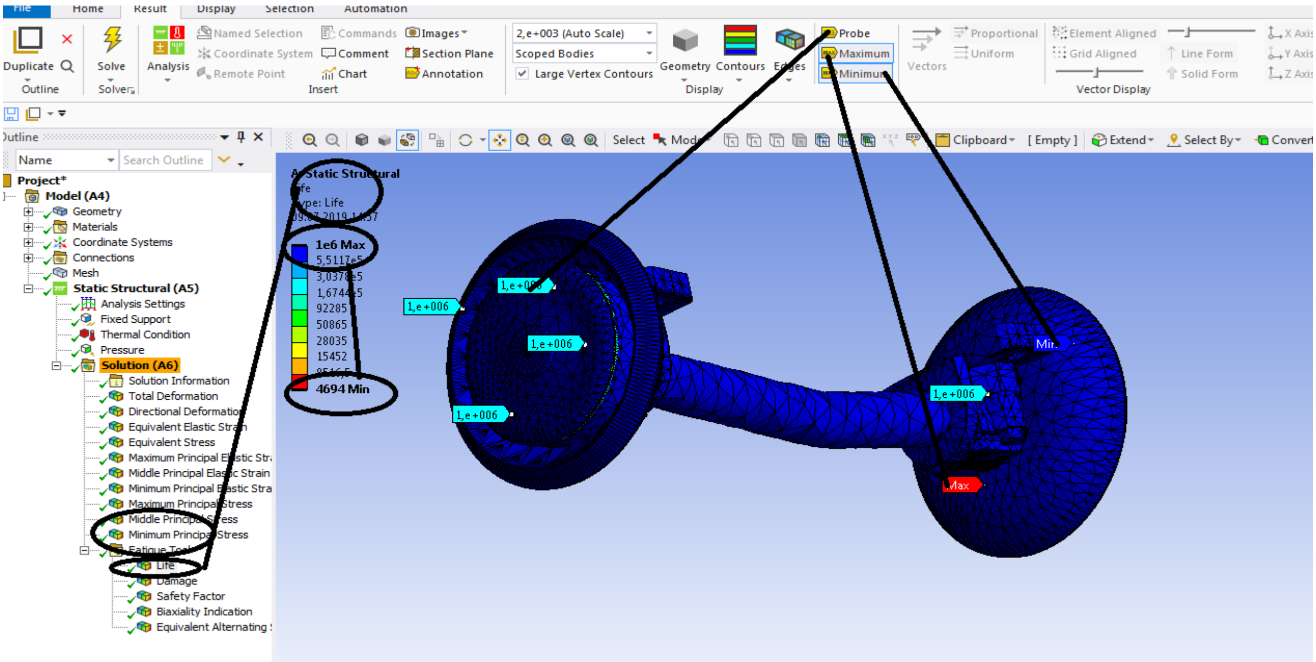


Figura 305 - Durata de viata [s]

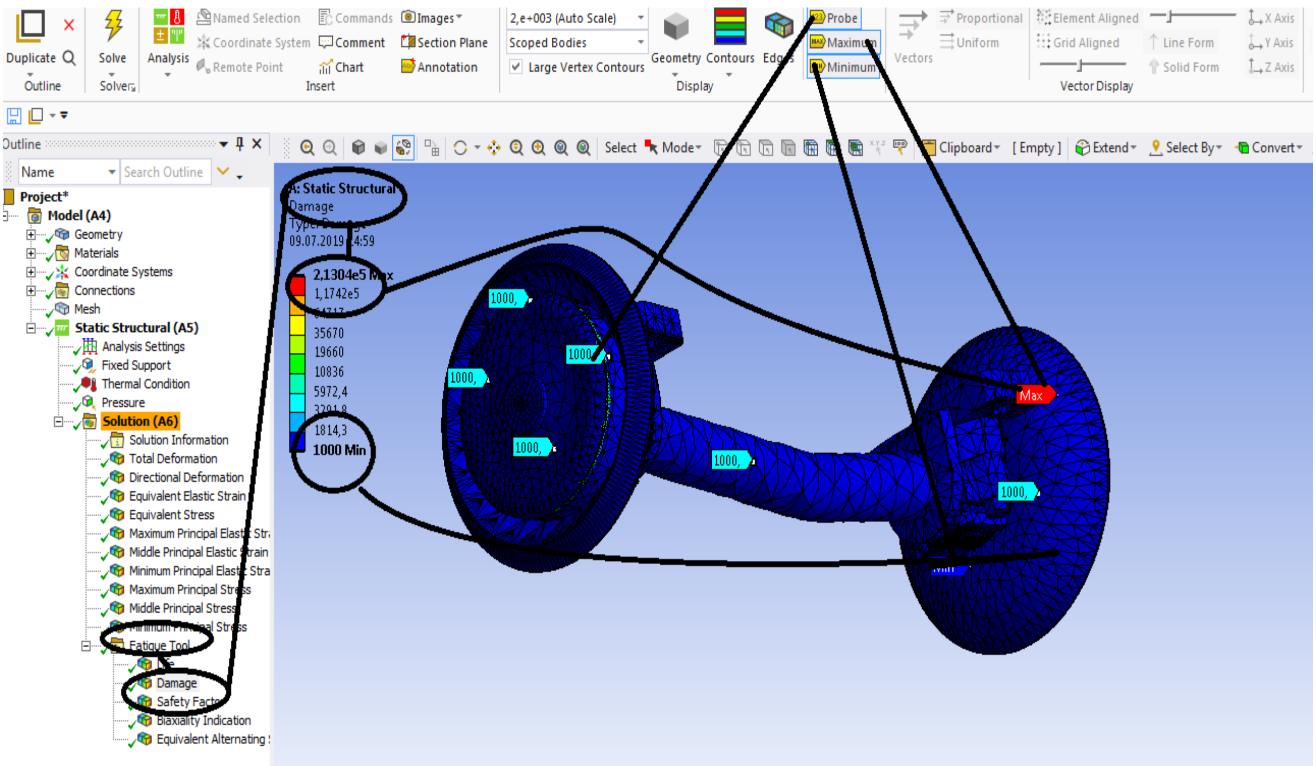


Figura 306 - Avarii [s]

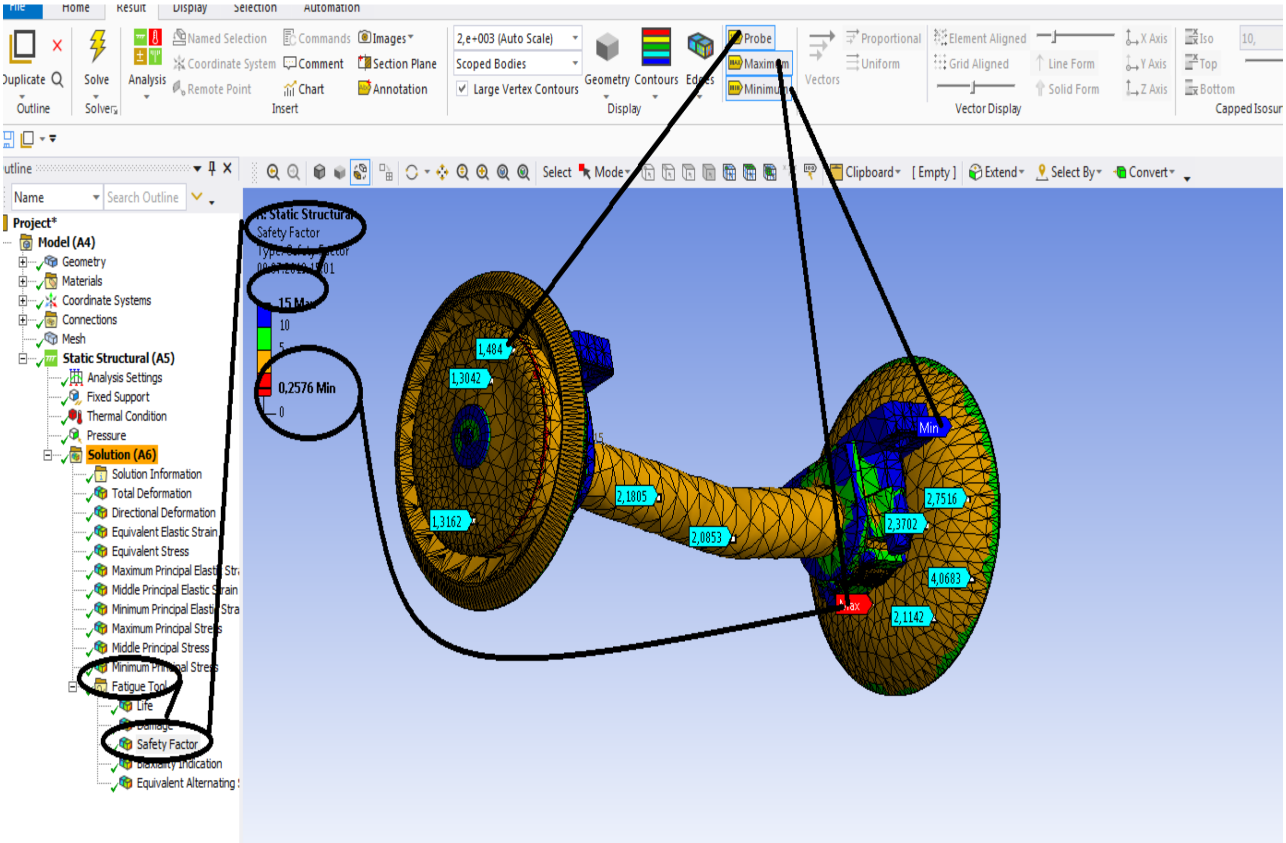


Figura 307 - Coeficientii de siguranta

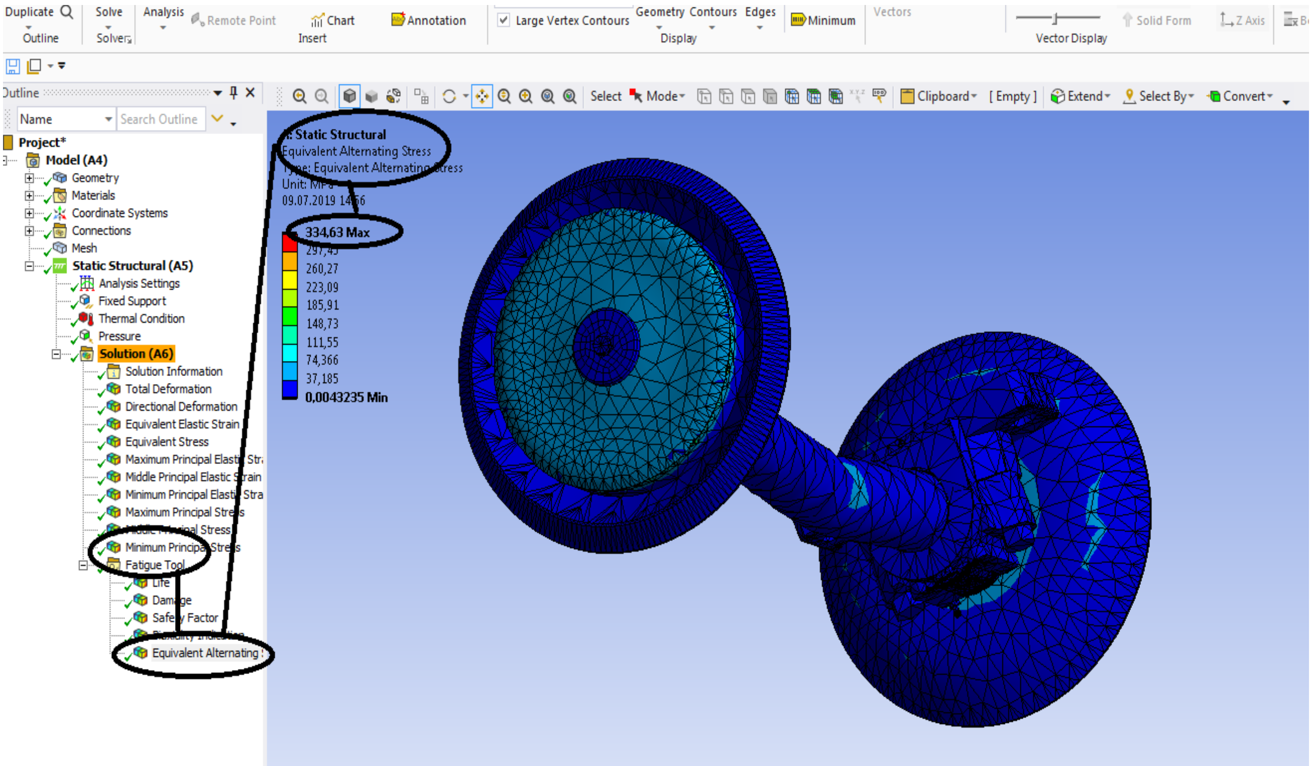


Figura 308 - Tensiunea la oboseala [MPa]

Capitol 6 -Analiza cu elemente finite pentru carligul de la vagoane de cale ferata

6.1 Static structural mecanic pentru carligul de la vagoane de cale ferata

-Rezultate

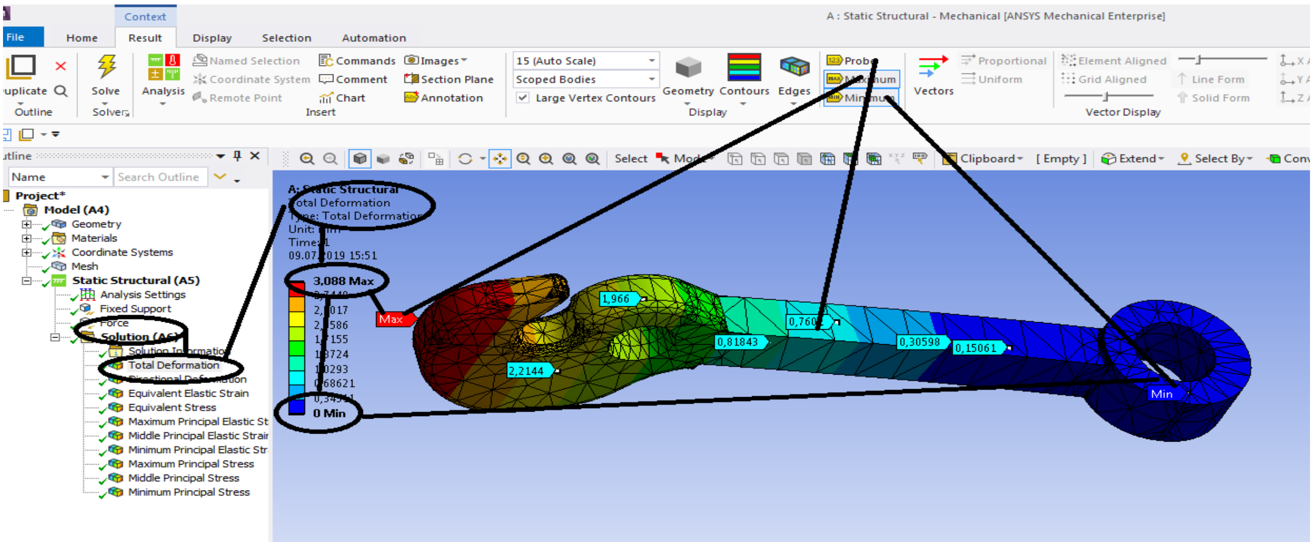


Figura 309 - Deformații totale [mm]

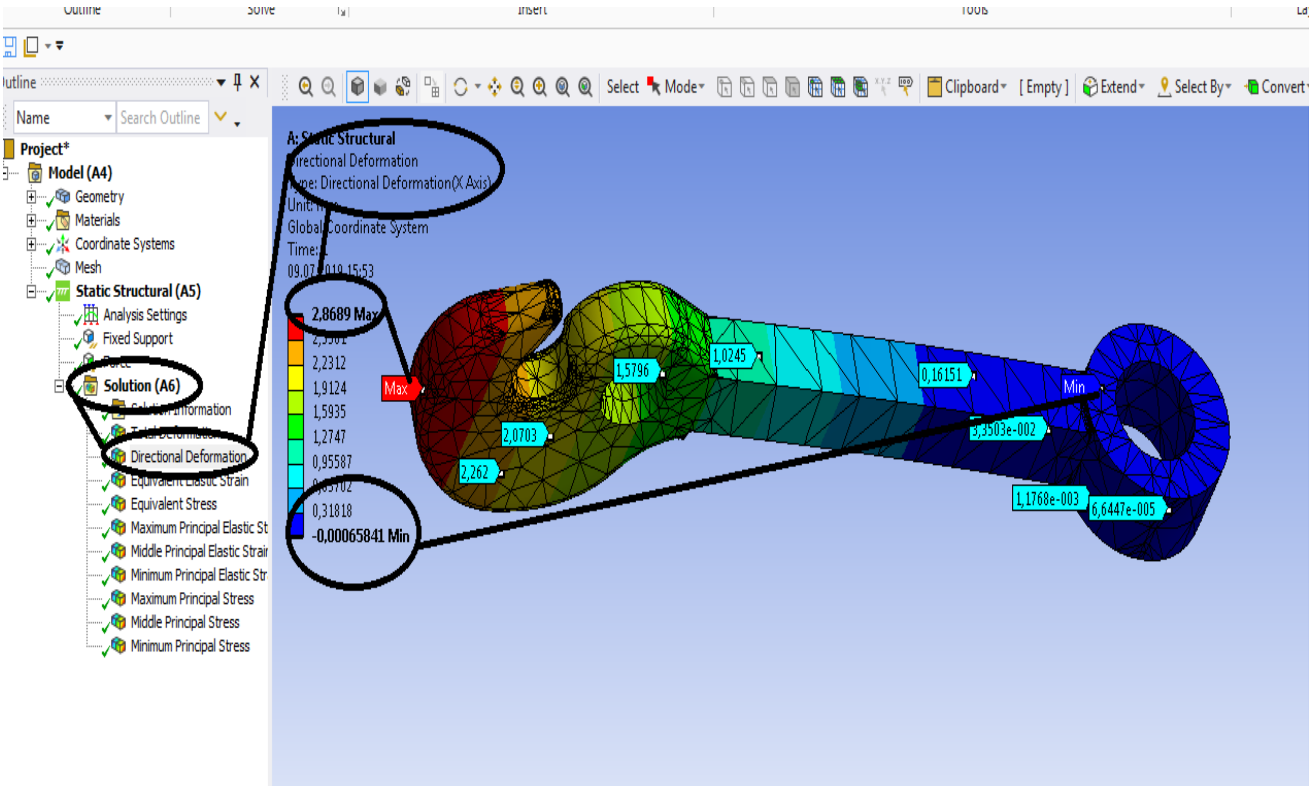


Figura 310 -Deformații direcționale pe axa x [mm]

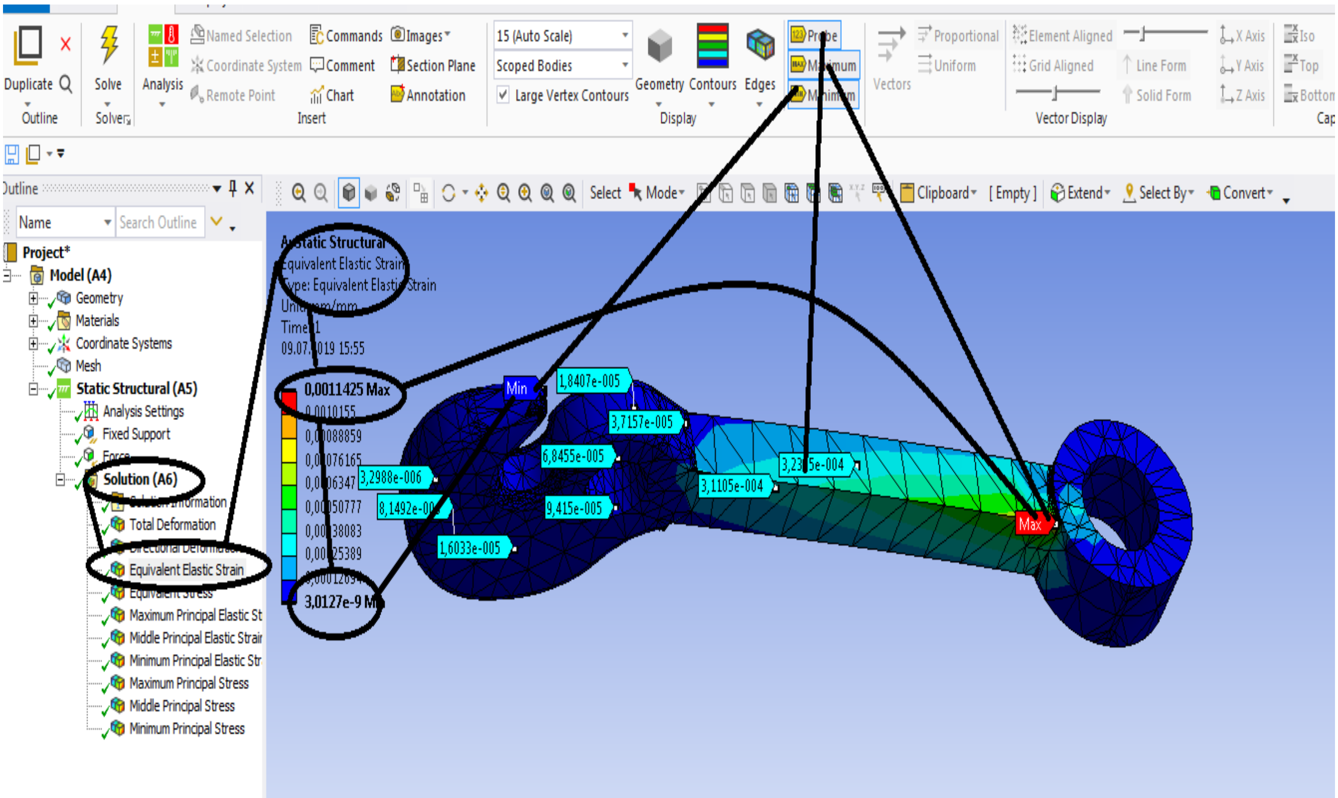


Figura 311 - Deformațiile specifice echivalente ε [mm/mm]

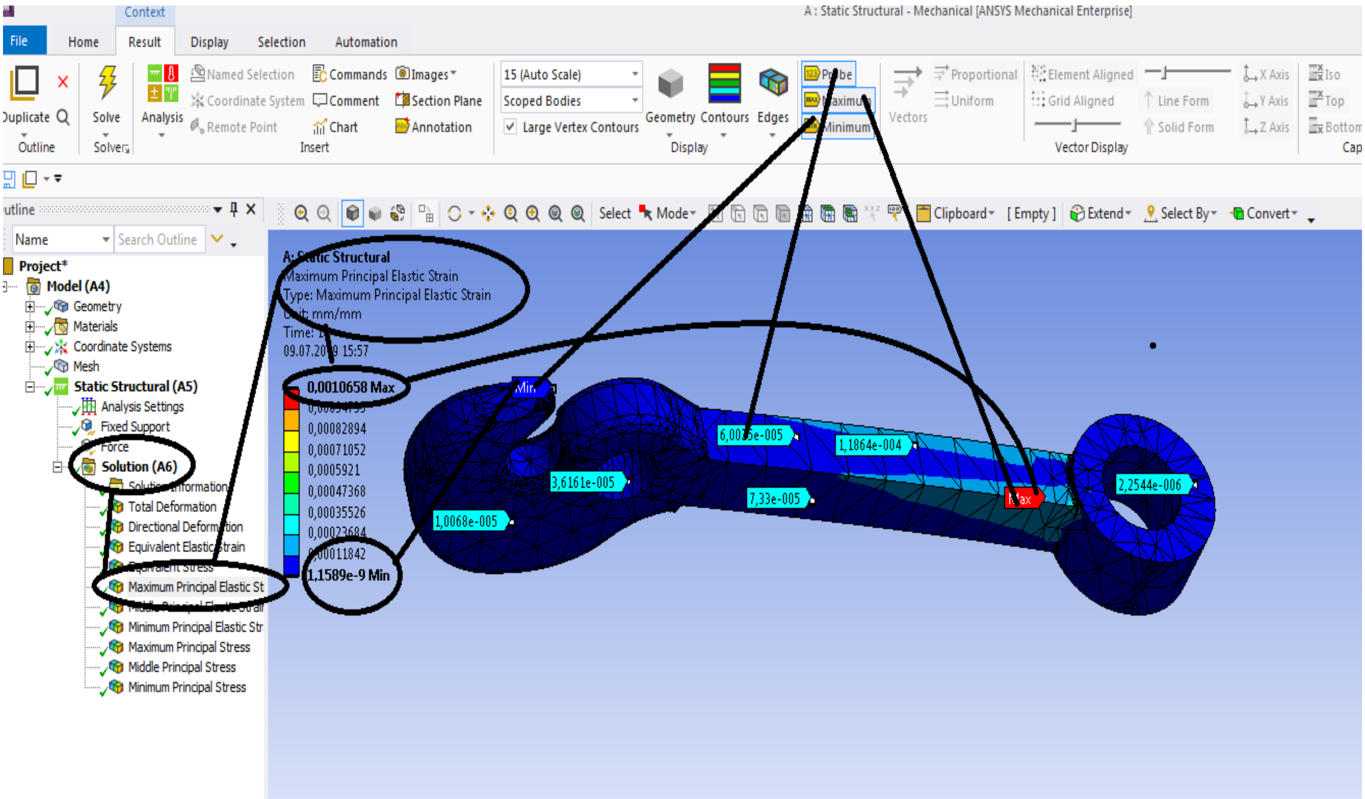


Figura 312 - Deformațiile specifice principale - ε1 [mm/mm]

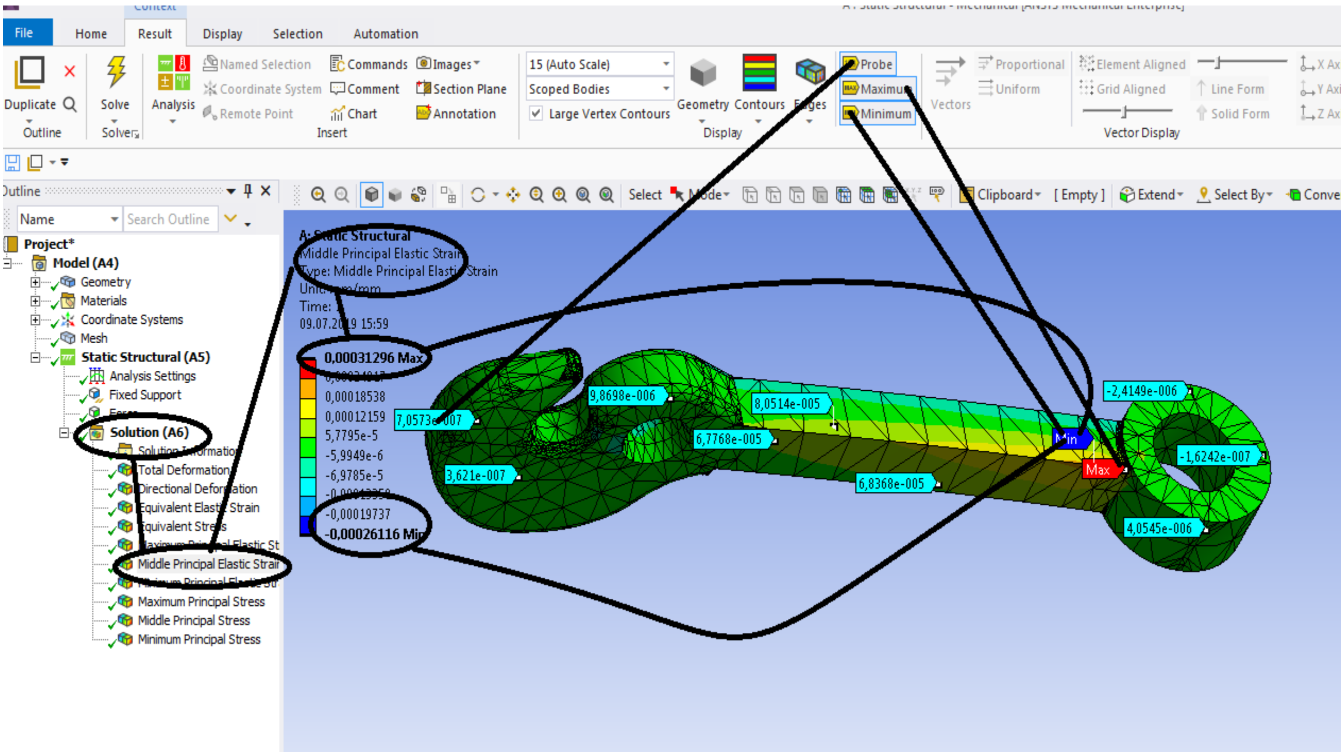


Figura 313 - Deformațiile specifice principale ε2 [mm/mm]

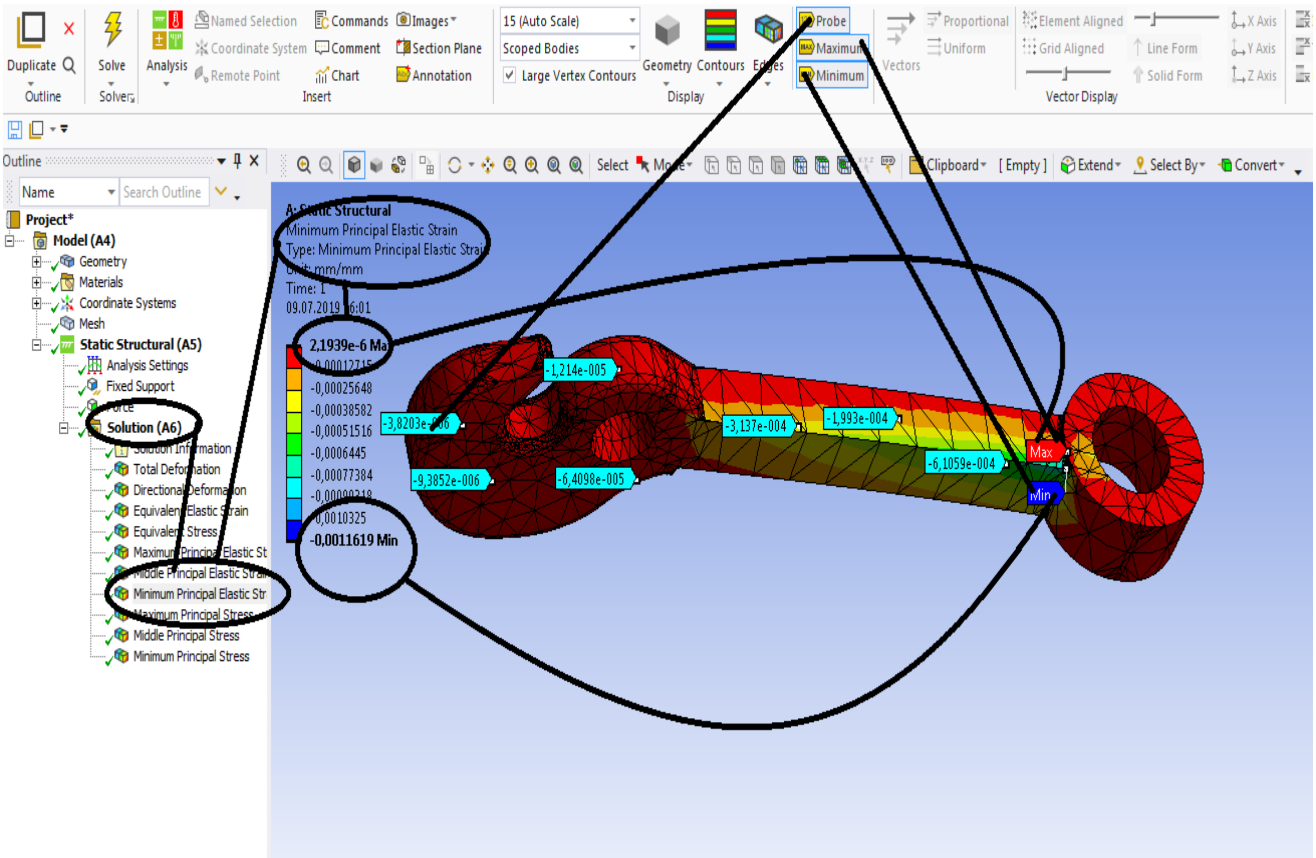


Figura 314 - Deformațiile specifice principale ε3 [mm/mm]

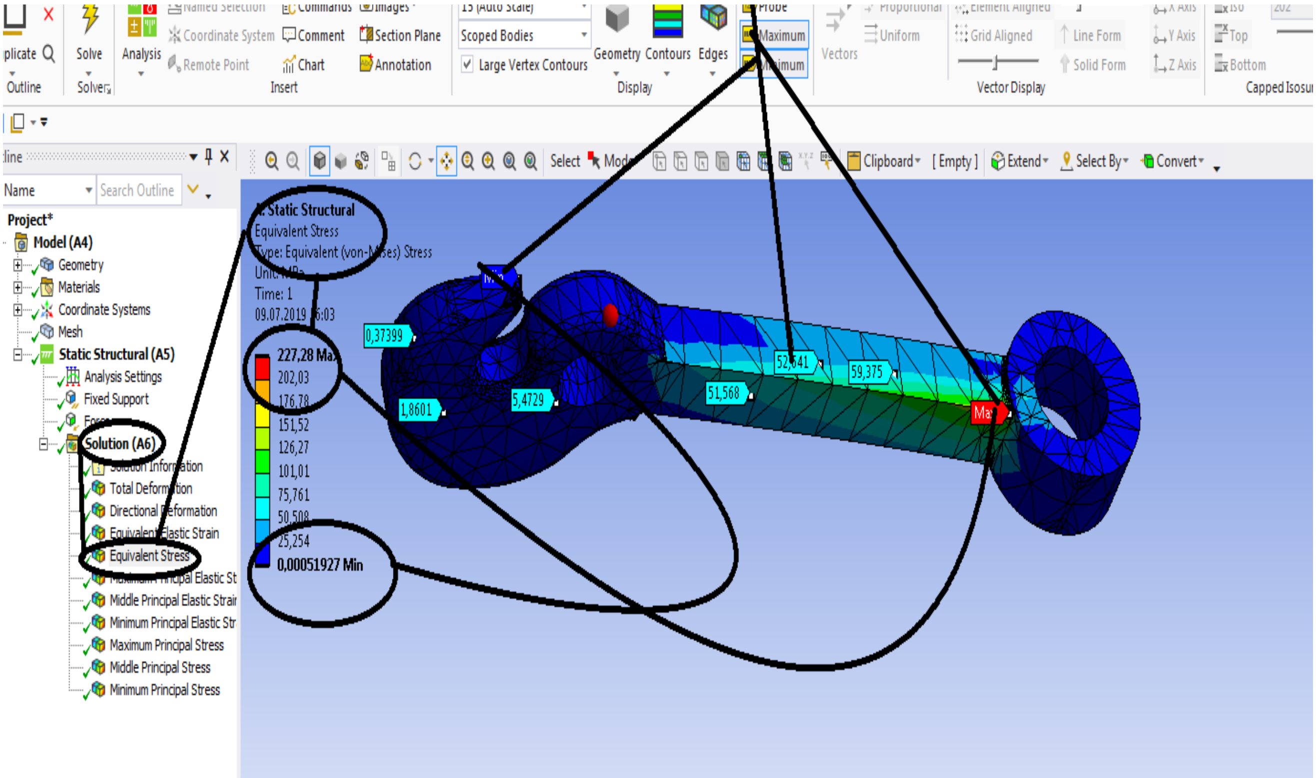


Figura 315 - Tensiunile echivalente von Mises [MPa]

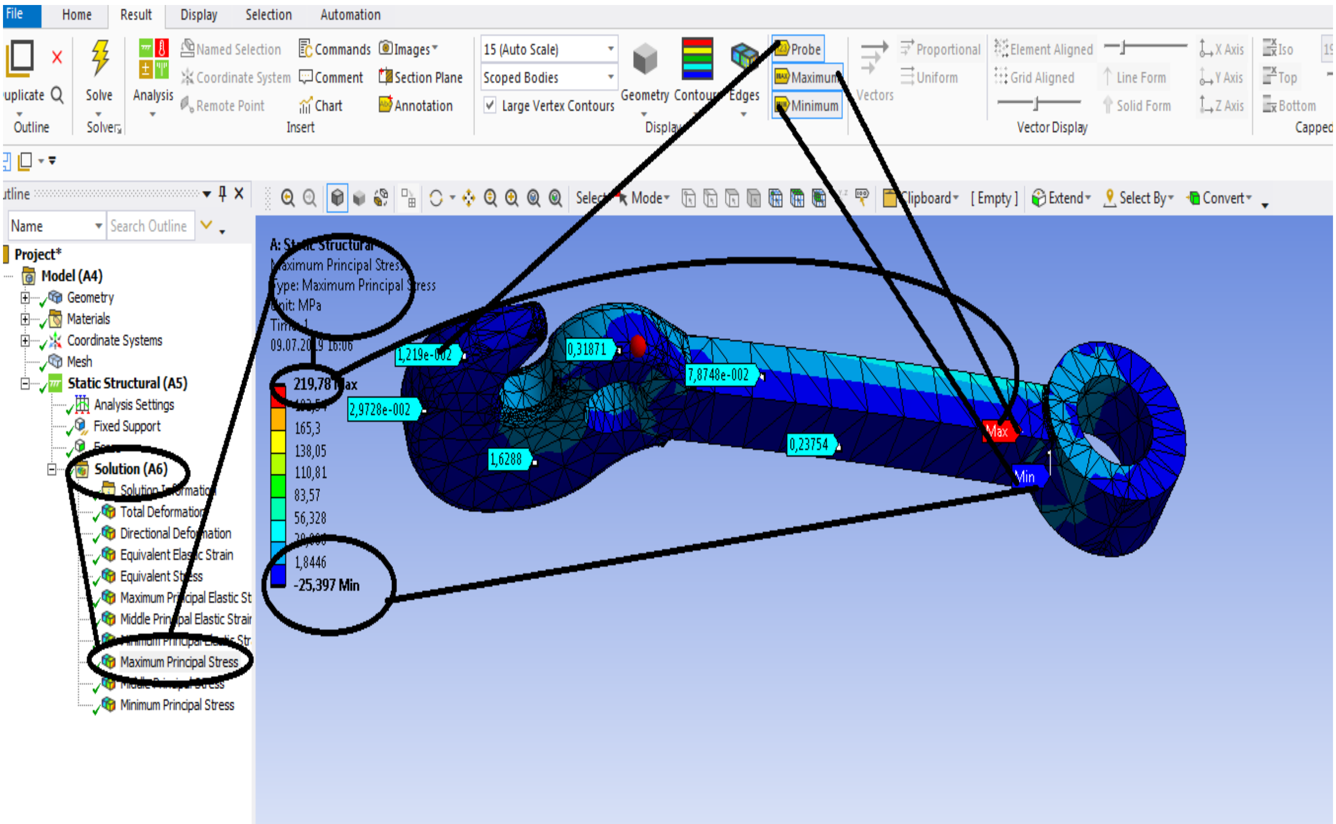


Figura 316 - Tensiunile principale $\sigma 1$ [MPa]

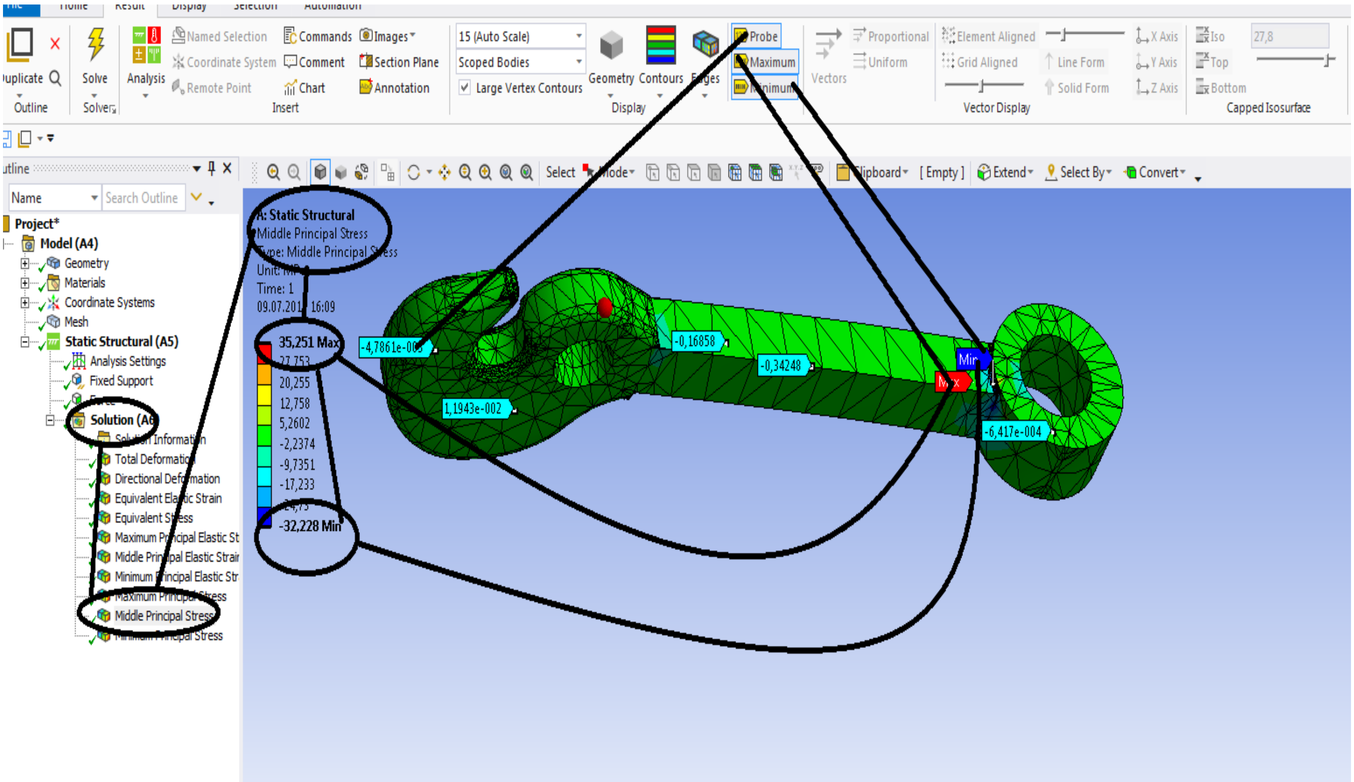


Figura 317- Tensiunile principale $\sigma 2$ [MPa]

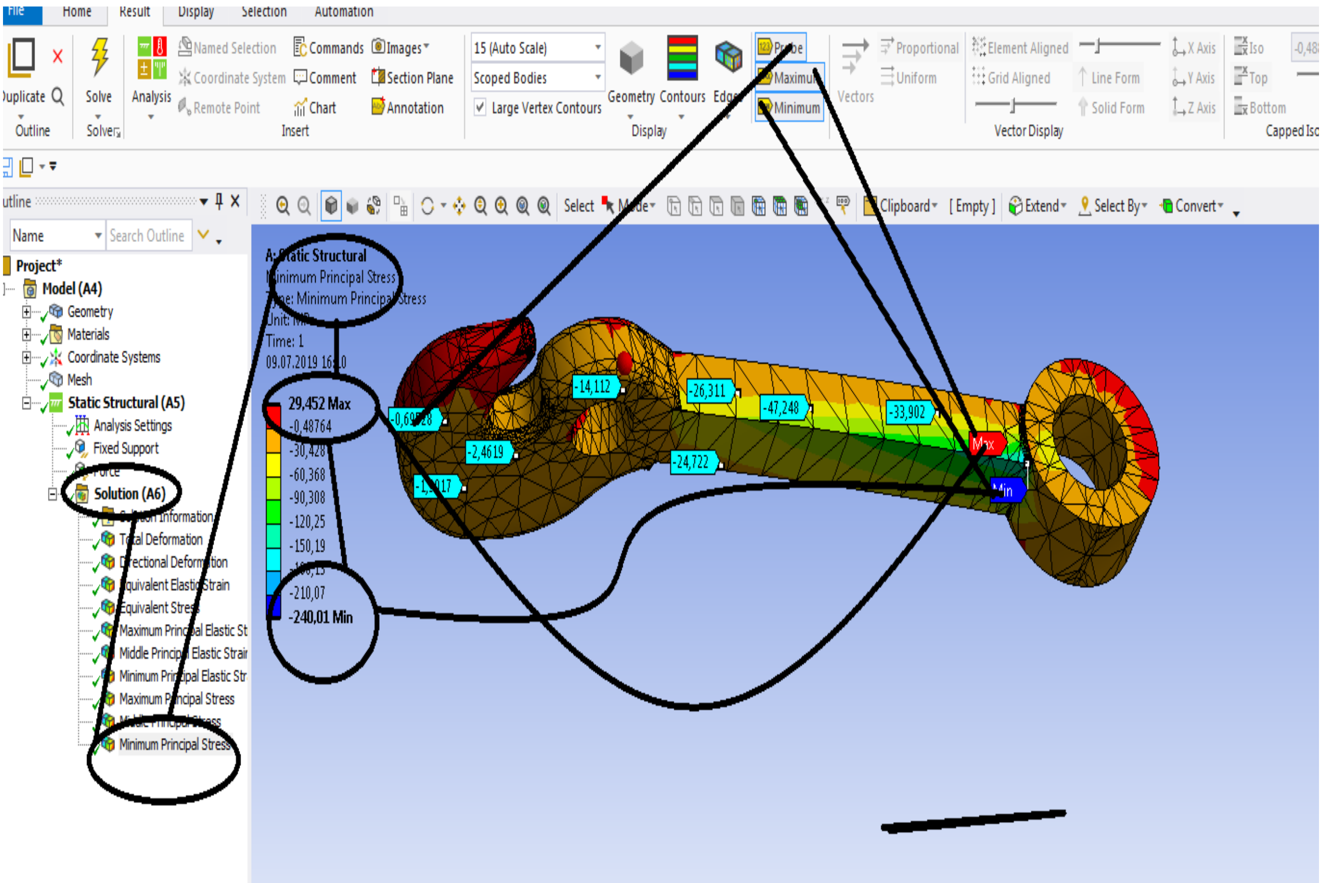


Figura 318 -Tensiunile principale $\sigma 3$ [MPa]

Capitol 7-Rigid dynamics

7.1 Boghiu vagon cale ferata cu acceleratia dupa toate componentele axelor de coordonate

- **Se deschide Ansys Workbench;**
- **Ia in stanga se alege Rigid dynamics si se da dublu clic dreapta;**
- **Apare in dreapta casuta Rigid Dynamics -A ;**

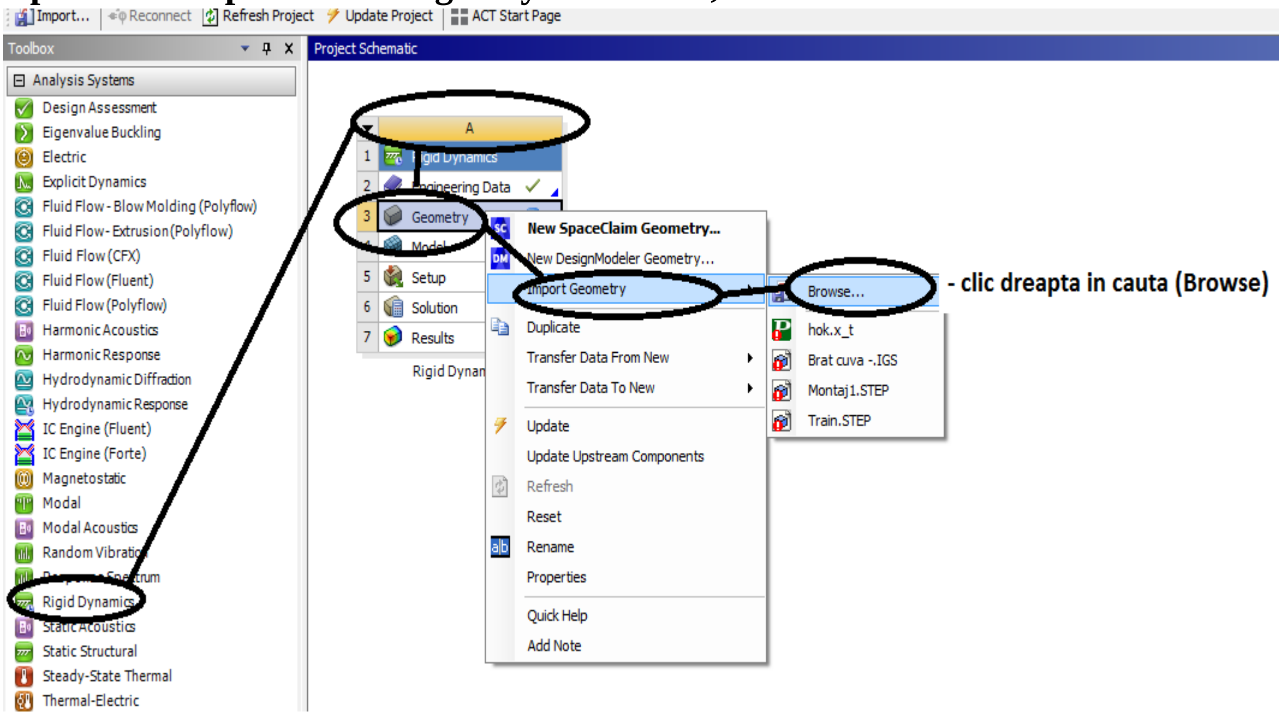


Figura 319 – Se deschide Rigid dinamics

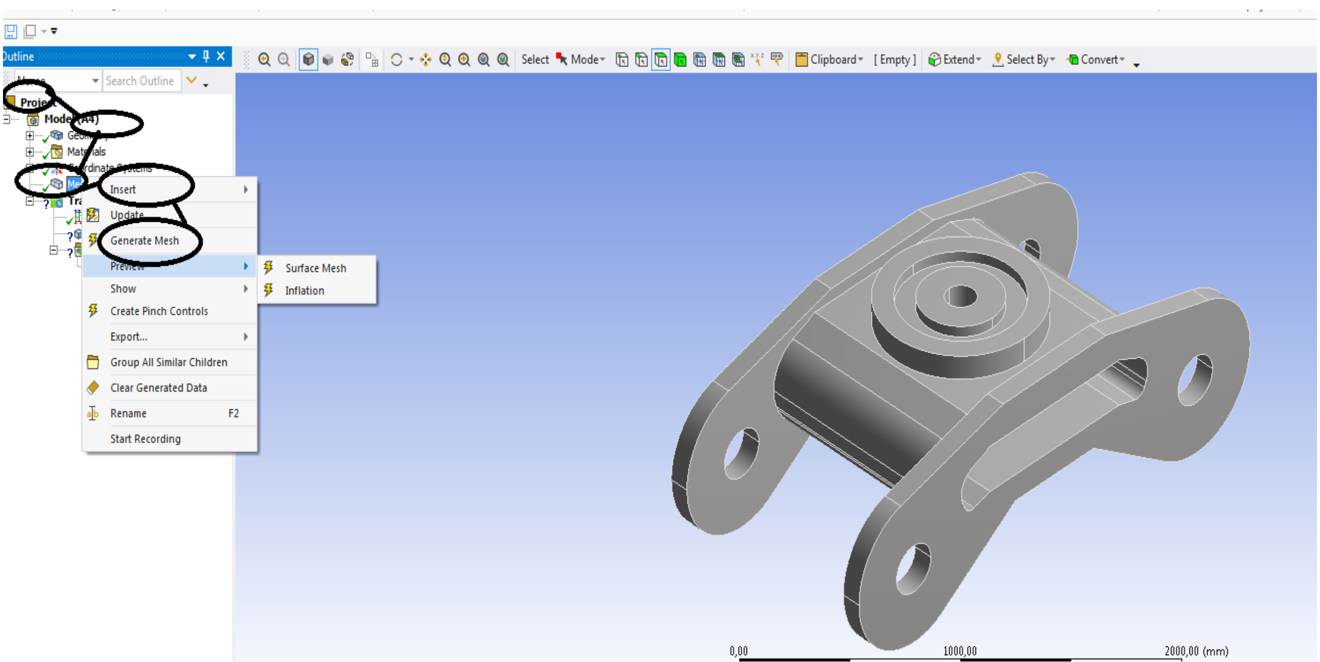


Figura 320 – Se discretizeaza boghiul

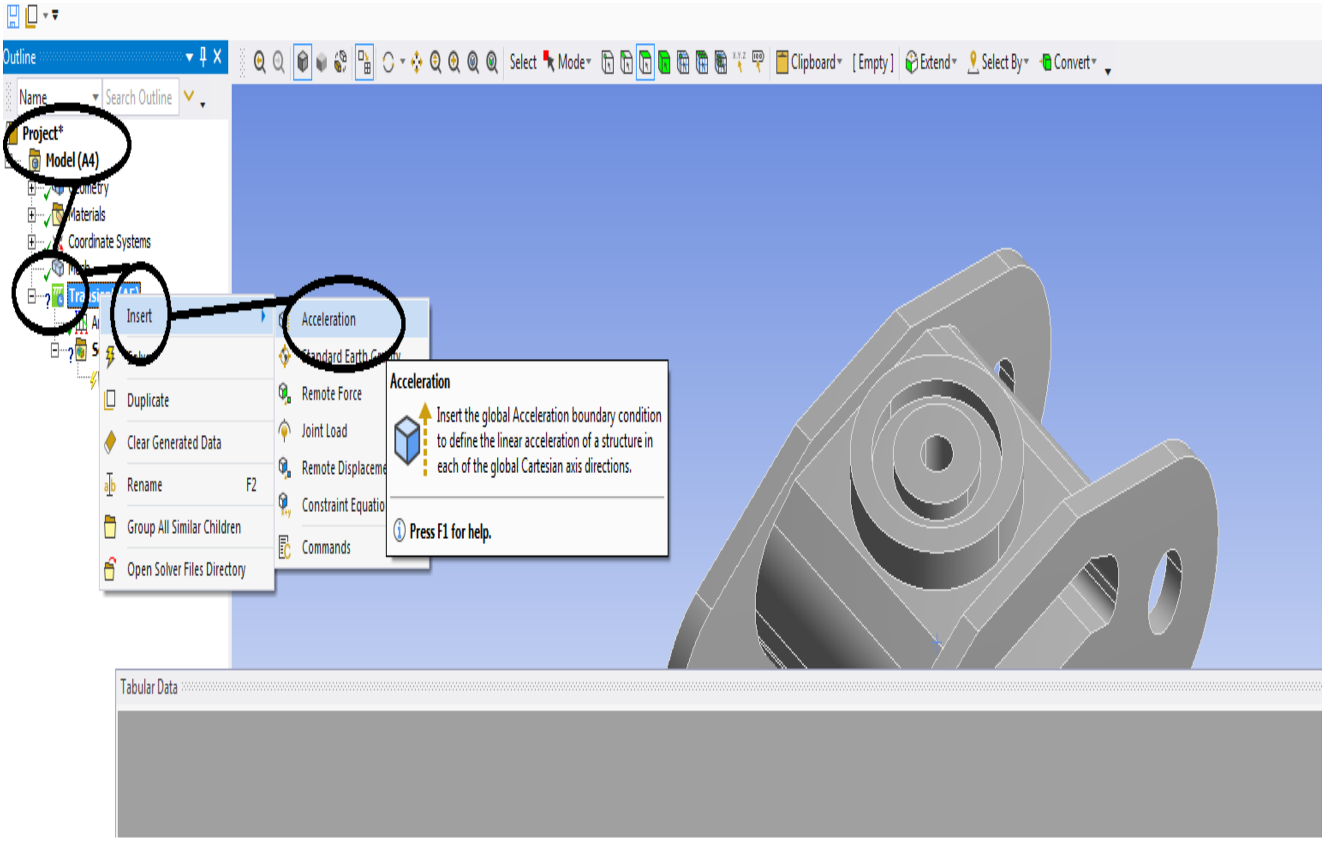


Figura 321 –se intra in Transient-Insert- Acceleration

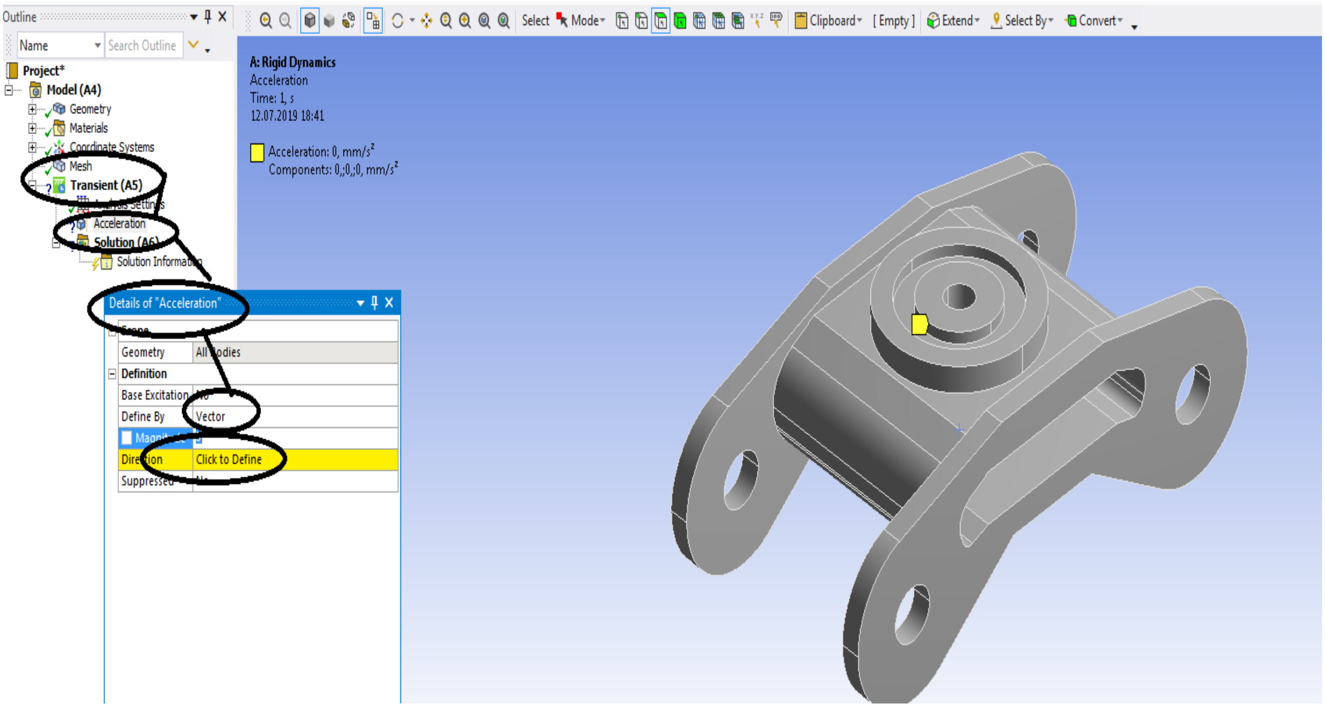


Figura 322 –se intra in Transient-Insert- Acceleration apoi clic dreapta- apare Detalils of „Acceleration”

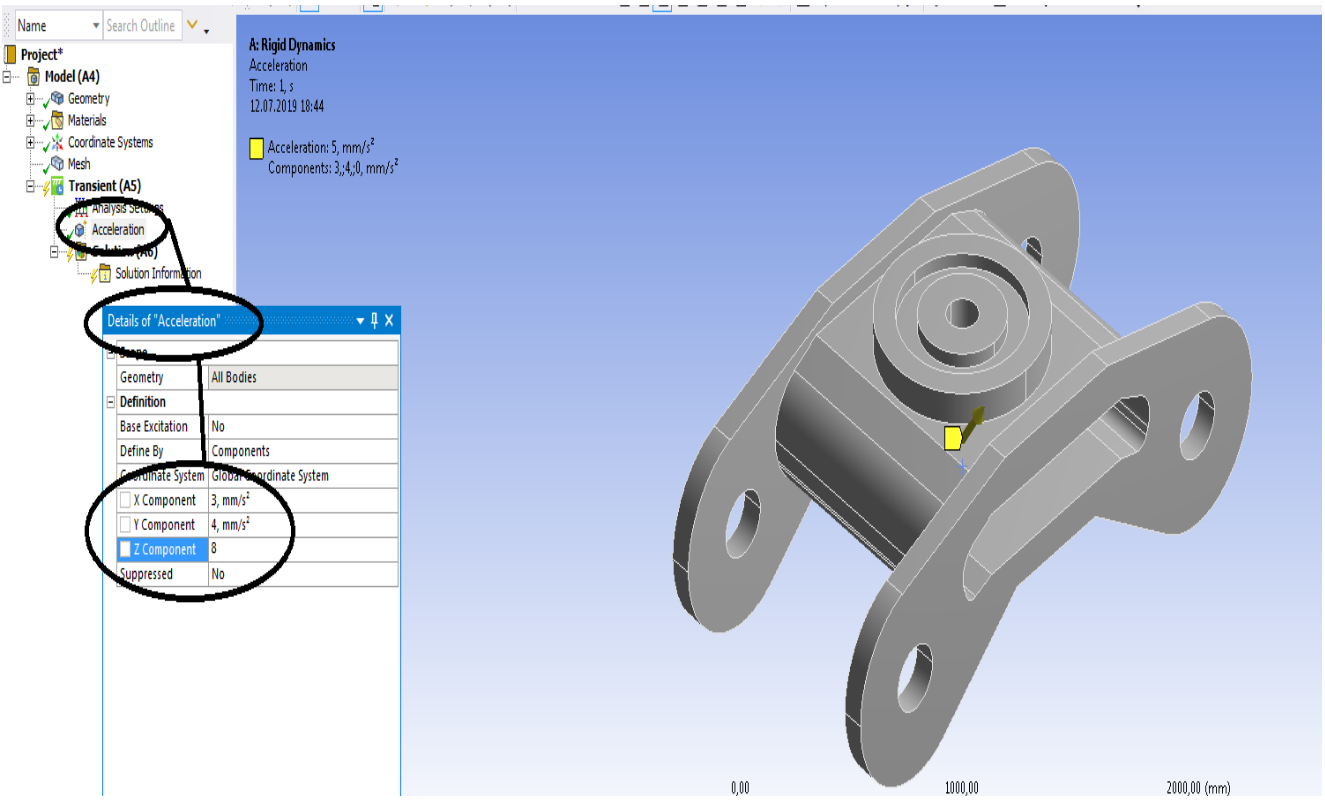


Figura 323 – Detalils of „Acceleration”- componentele acceleratiei pe axele de coordonate

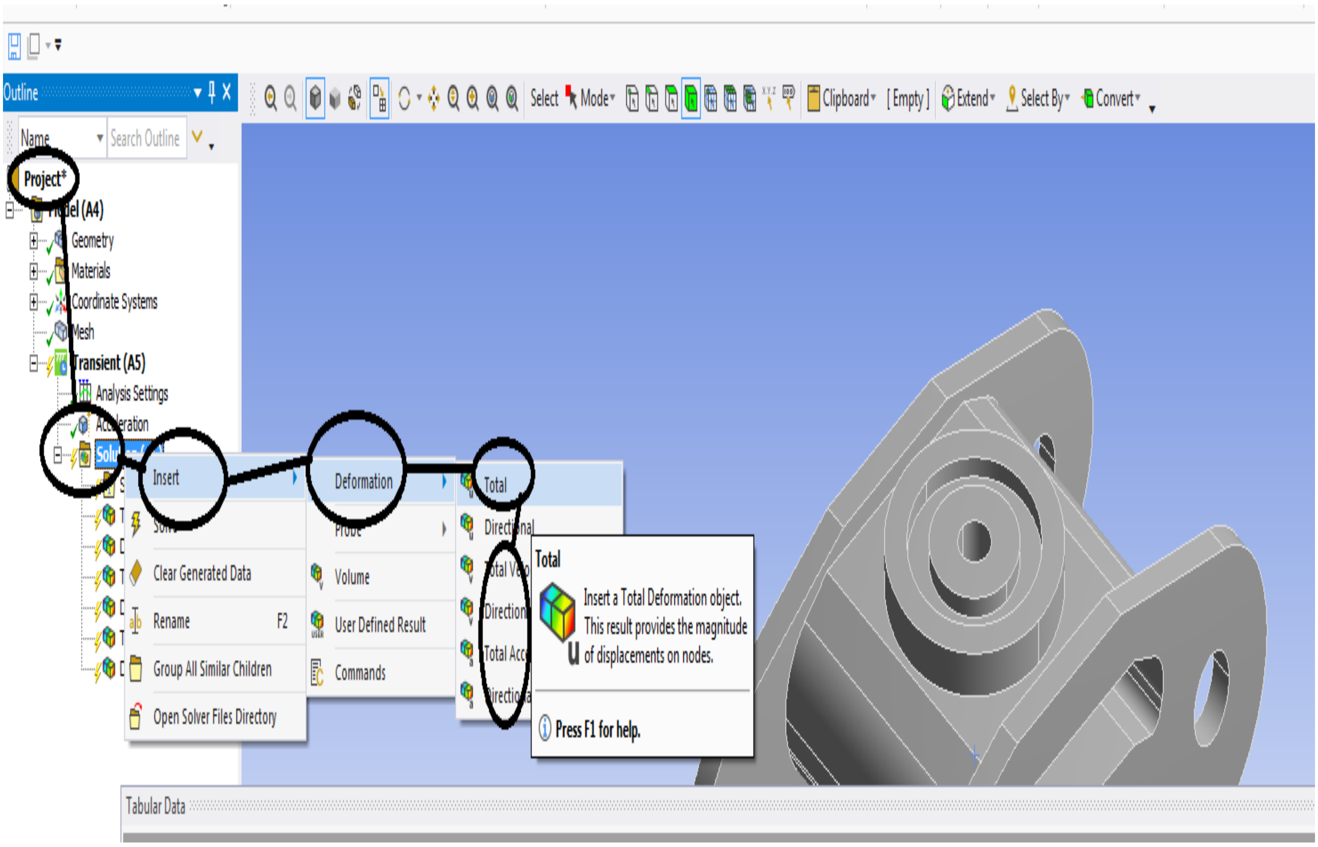


Figura 324 – Solution – Deformation - Total – Direction

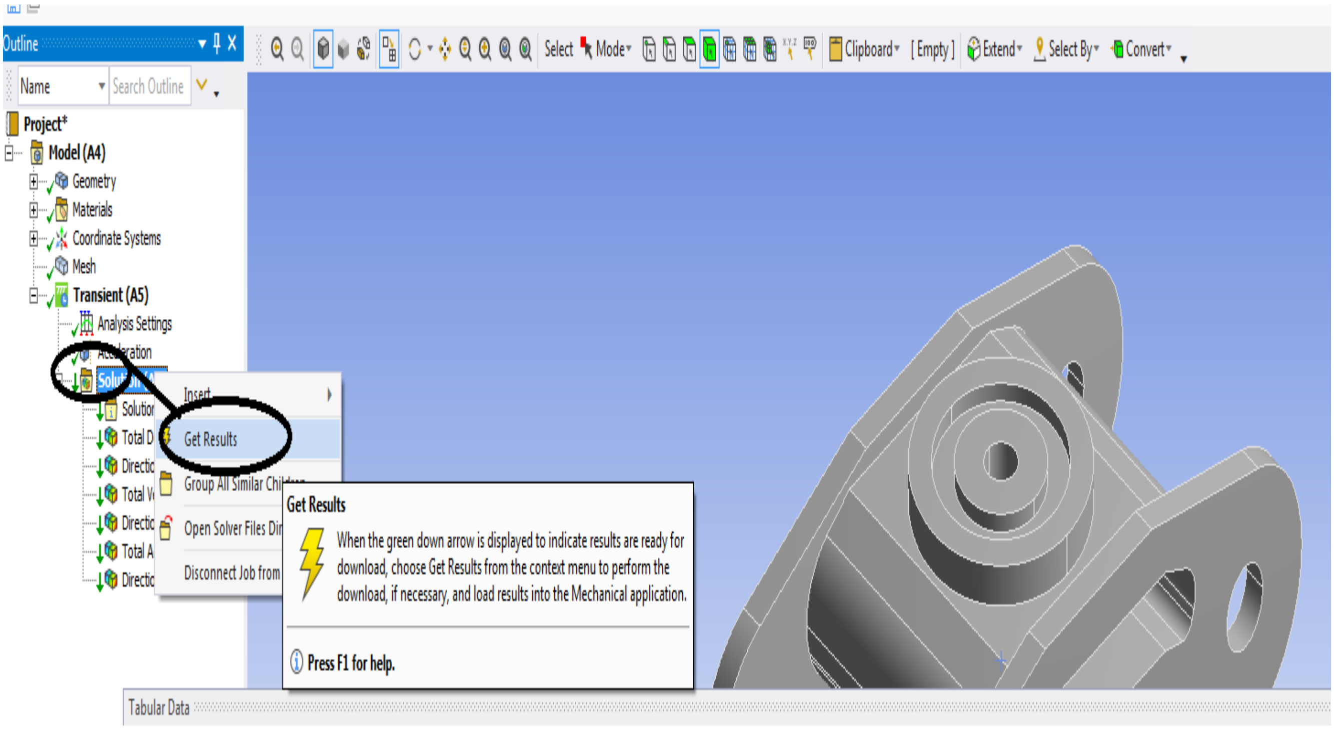


Figura 325 – Solution – apoi Get Results

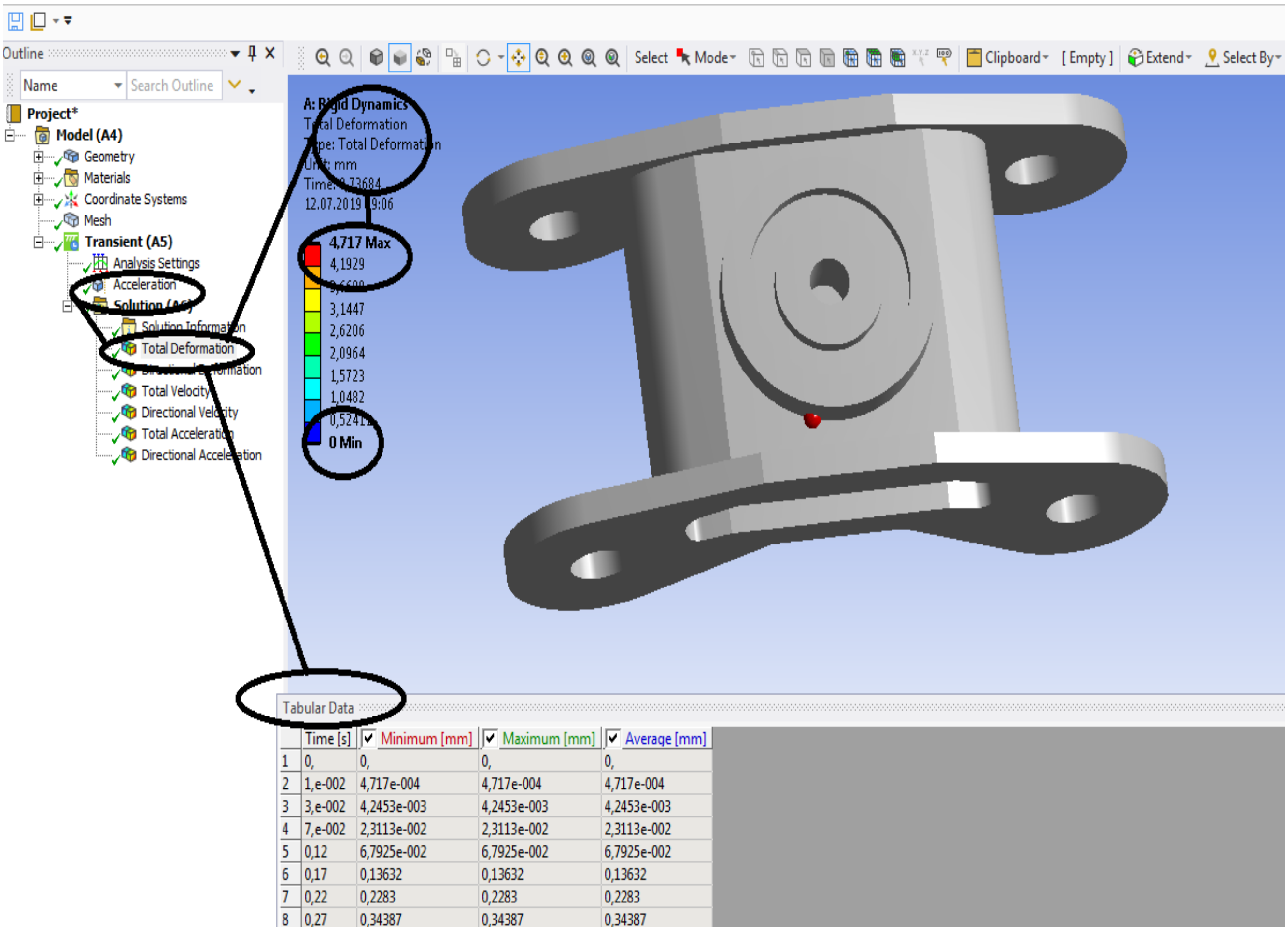


Figura 326 – Deformatii totale [mm]

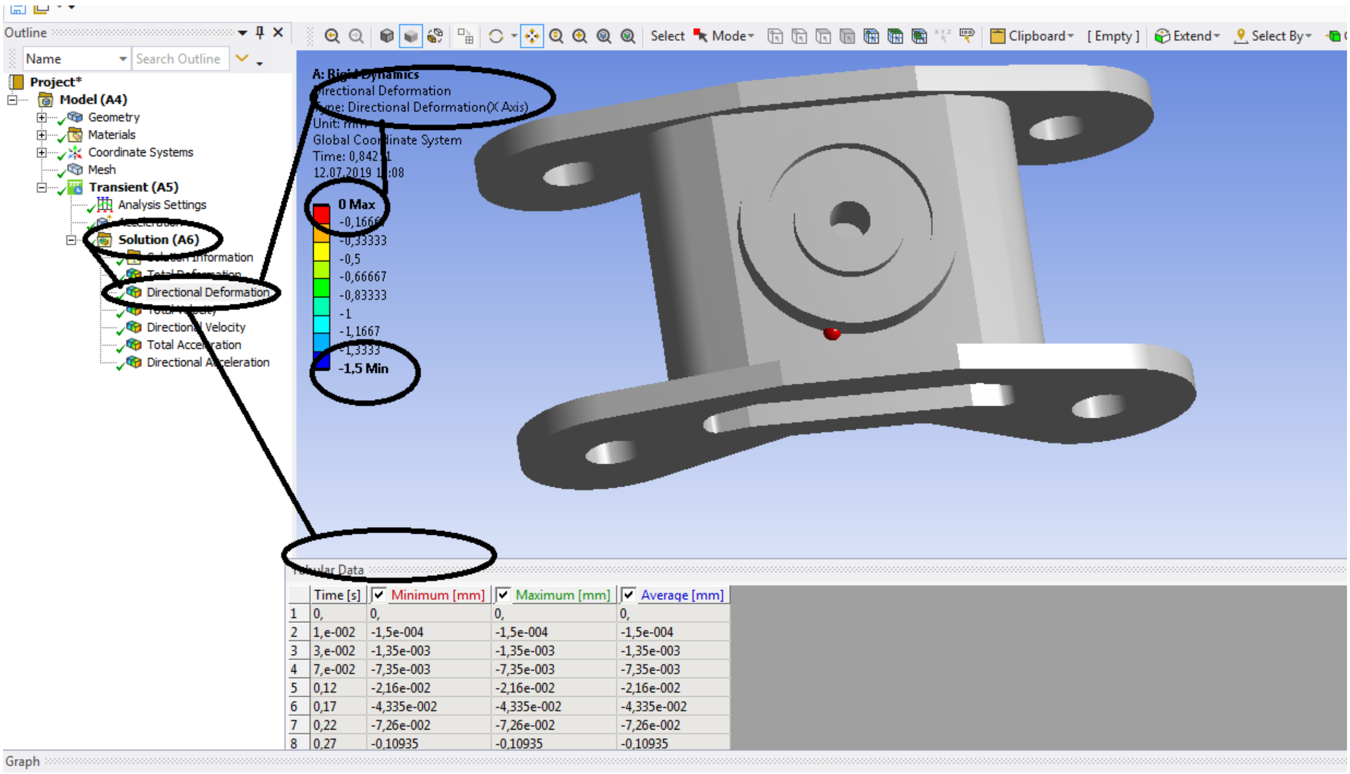


Figura 327 – Deformatii dupa axa OX [mm]

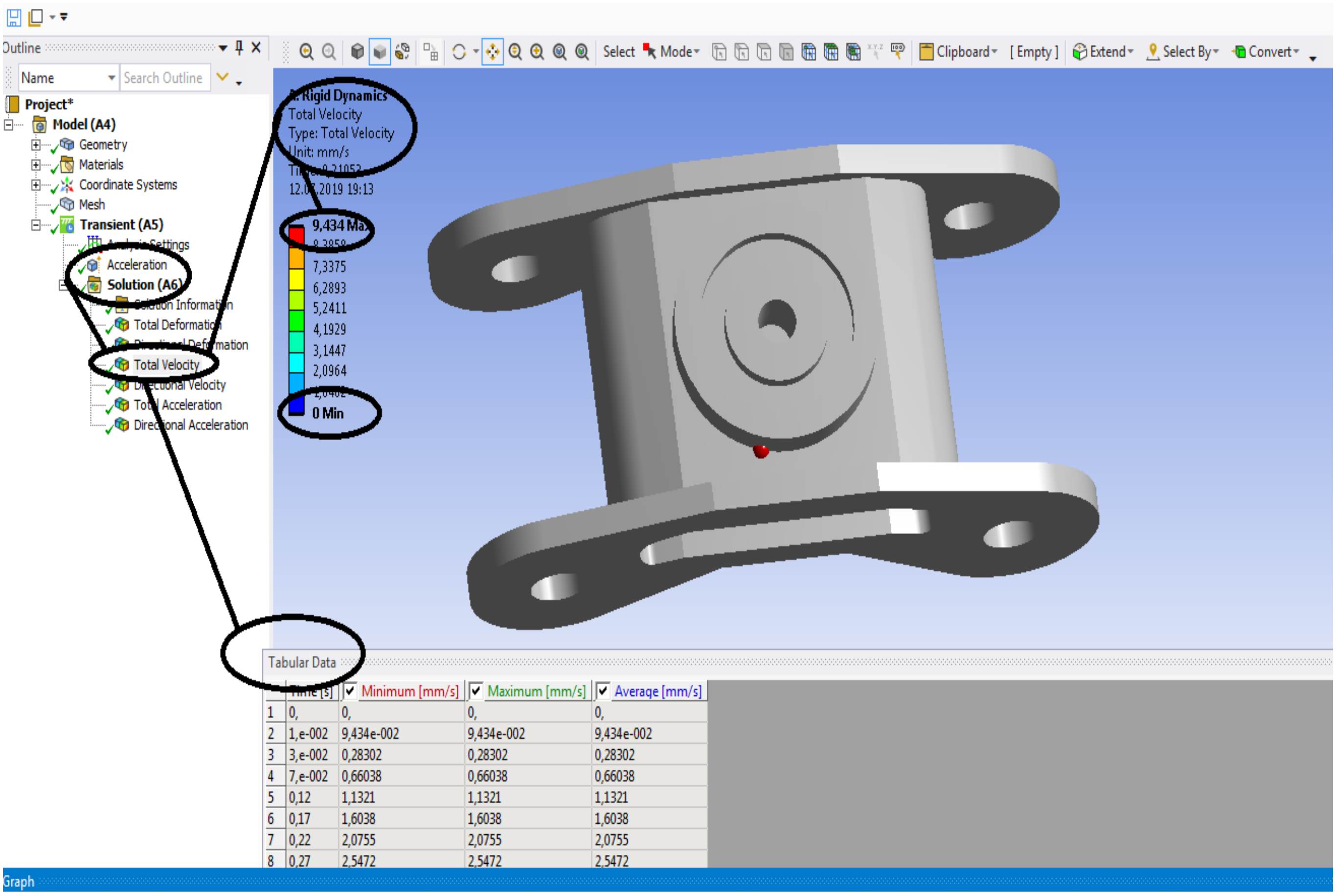


Figura 328 – Vitezele totale [mm/s]

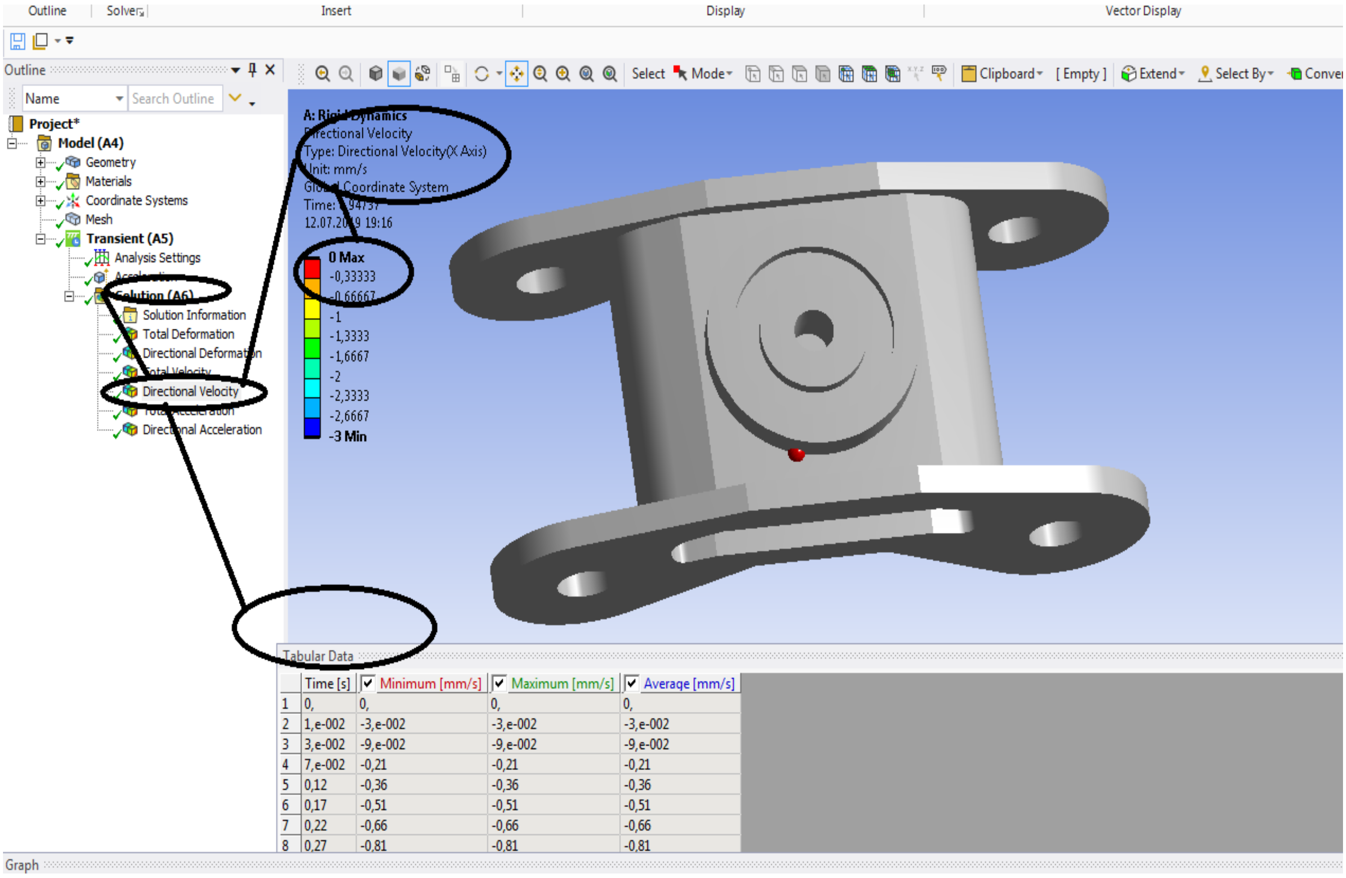


Figura 329 – Vitezele dupa axa OX [mm/s]

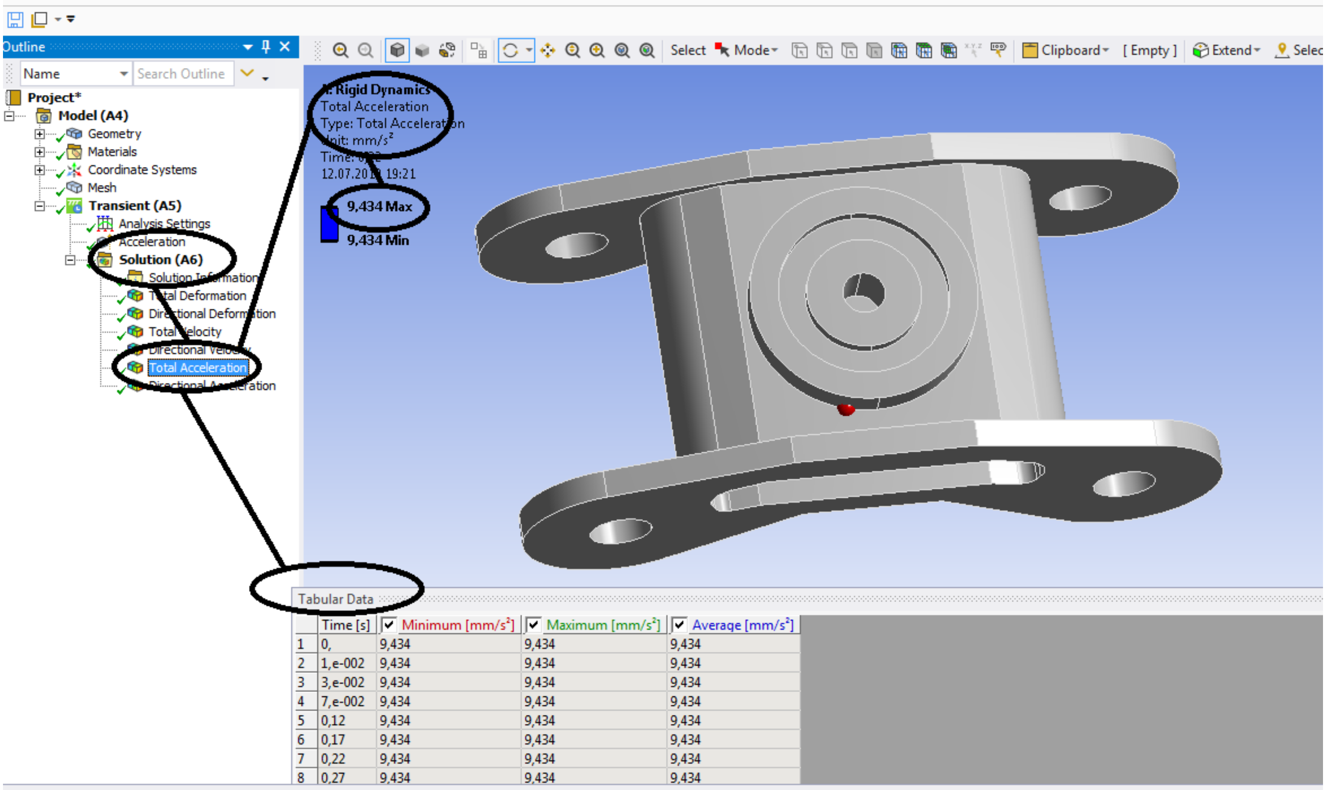


Figura 330 – Acceleratiile totale [mm/s^2]

Rigid dynamics

7.2 Boghiu vagon cale ferata- Acceleratia numai pe axa OX

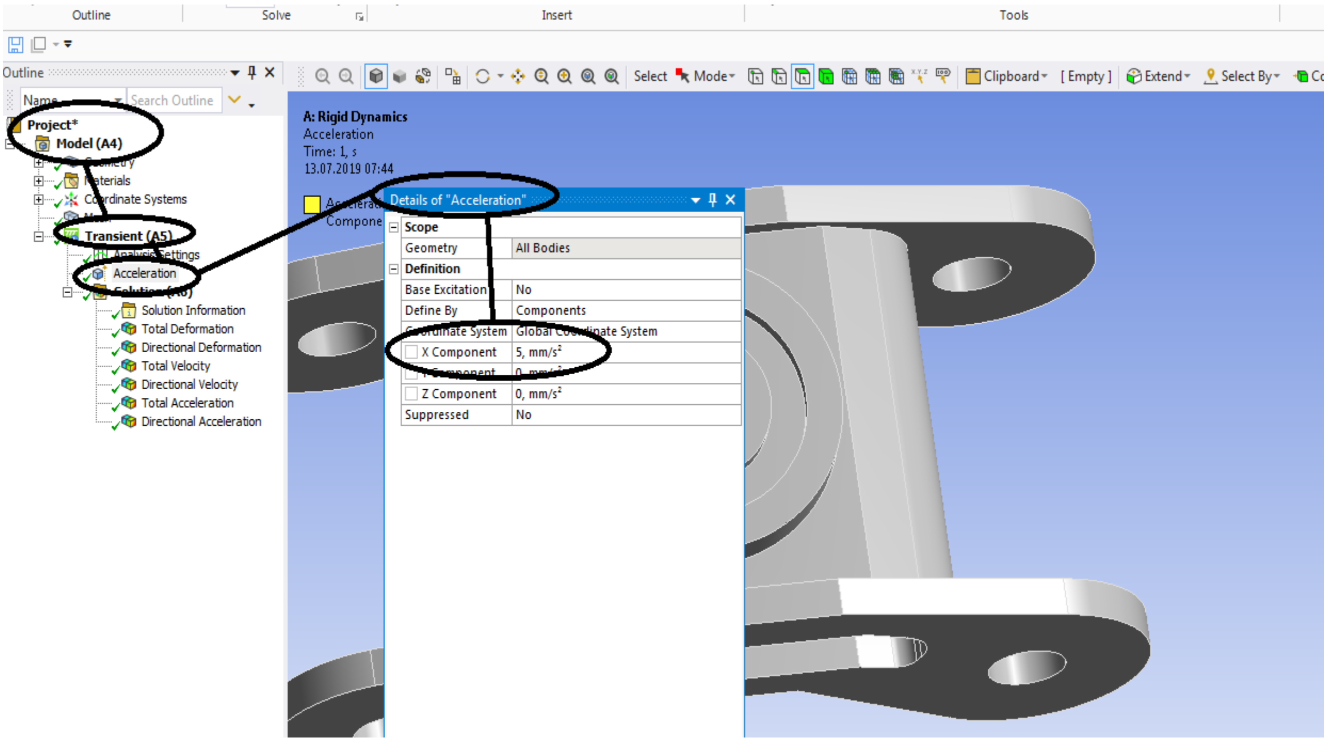


Figura 331 –Acceleratia dupa axa OX

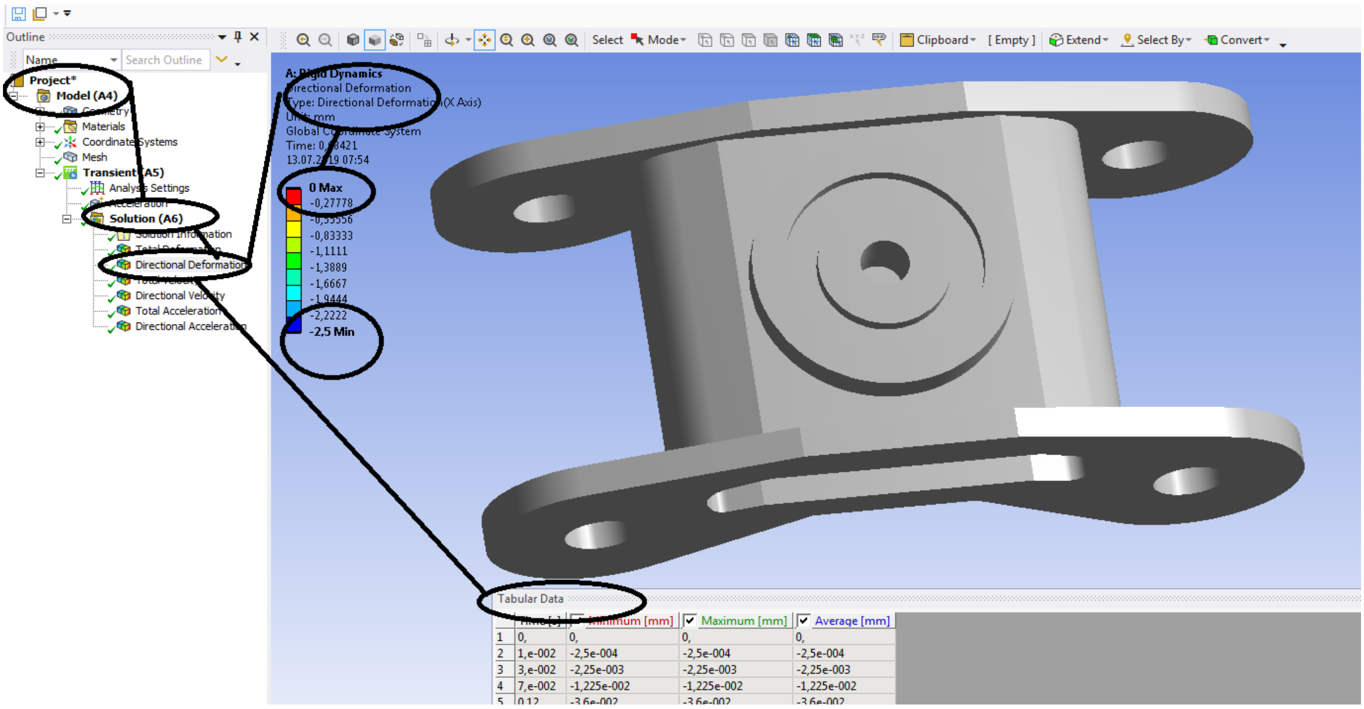


Figura 332 -Deformații direcționale pe axa x [mm]

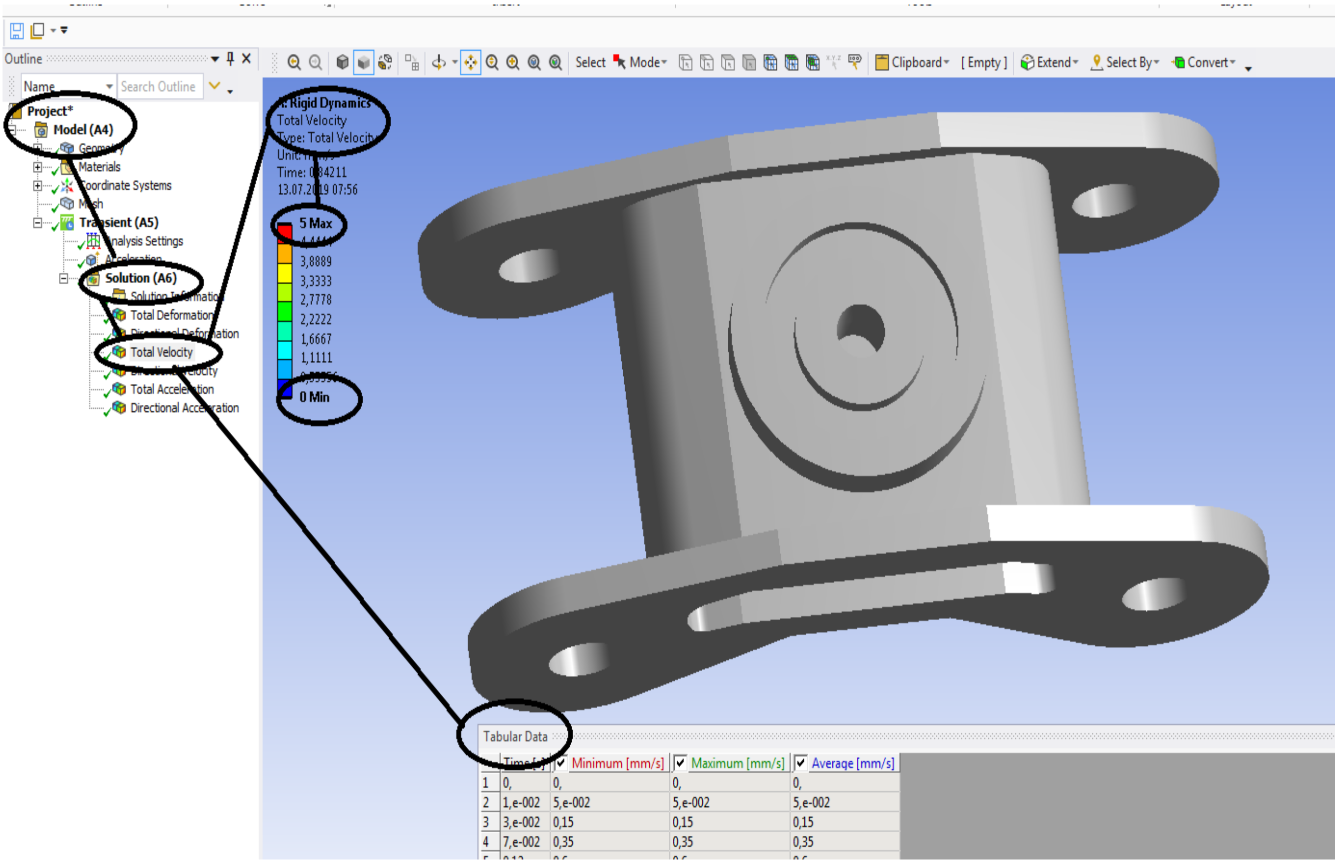


Figura 333 – Vitezele totale [mm/s]

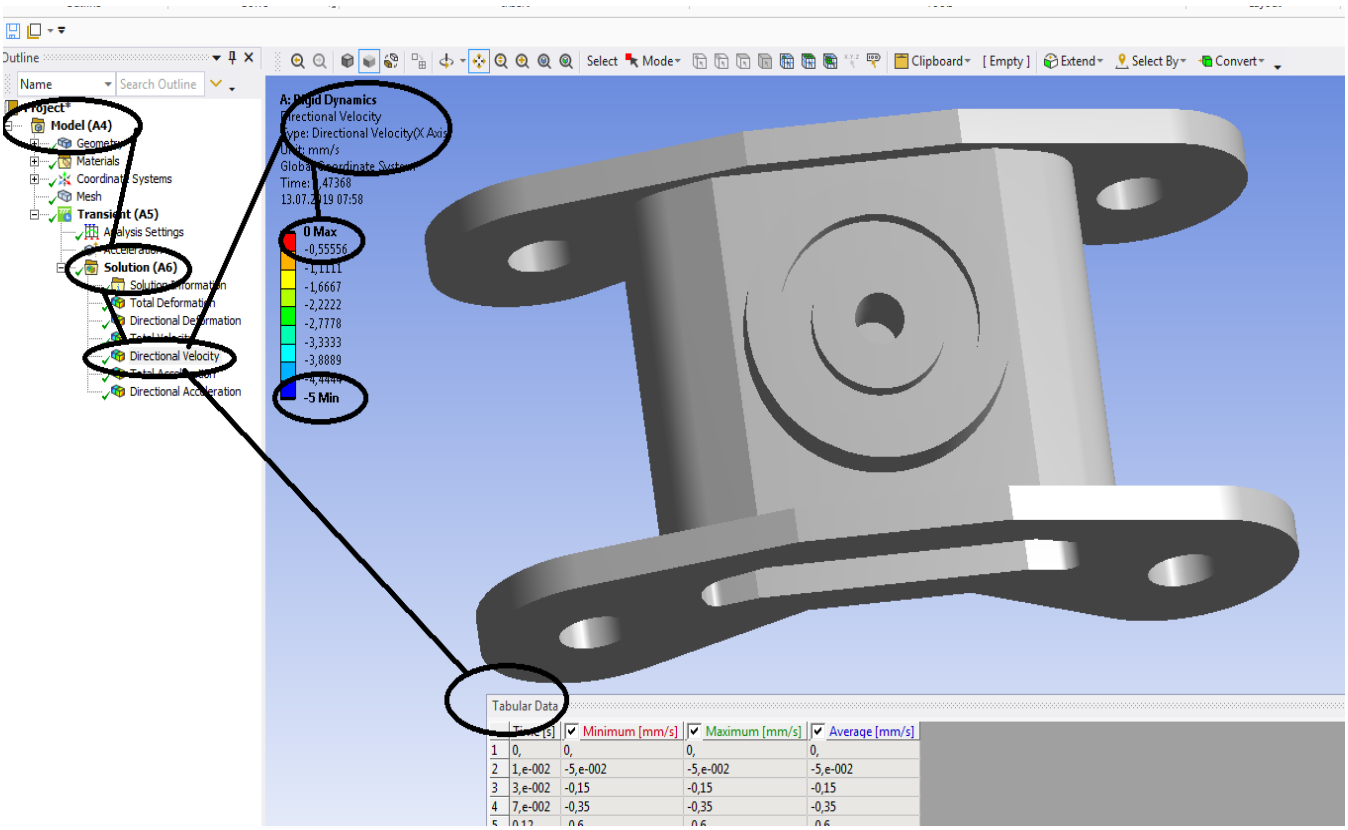


Figura 334 – Vitezele dupa axa OX [mm/s]

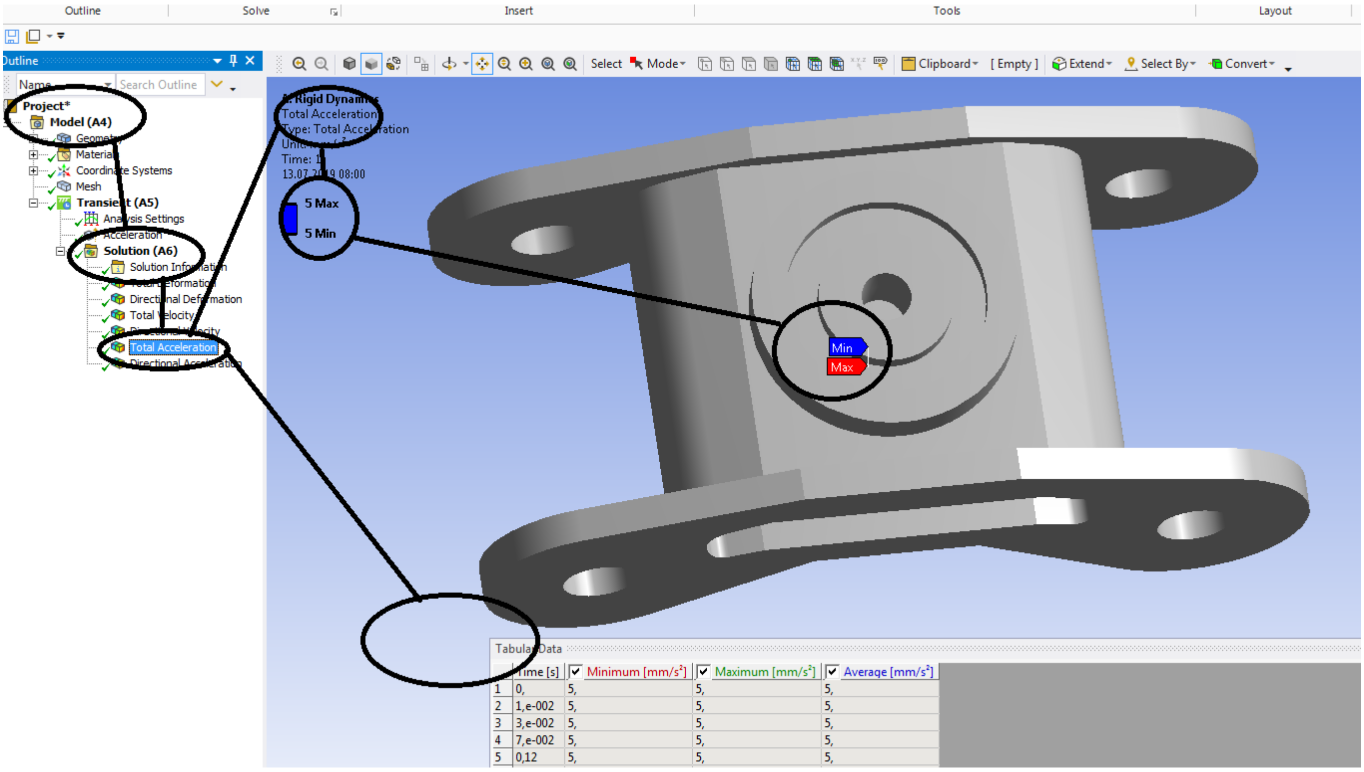


Figura   335 – Acceleratiile totale [mm/s^2]

Rigid dynamics

7.3 Boghiu vagon cale ferata- Acceleratia numai pe axa OY

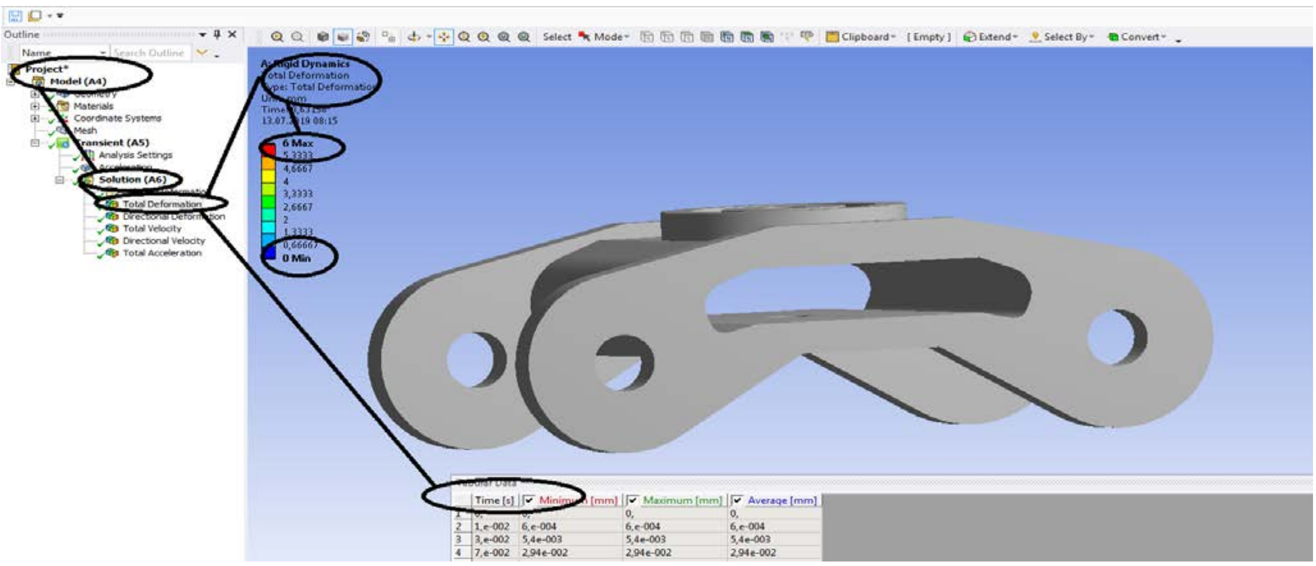


Figura 336 - Deformații totale [mm]

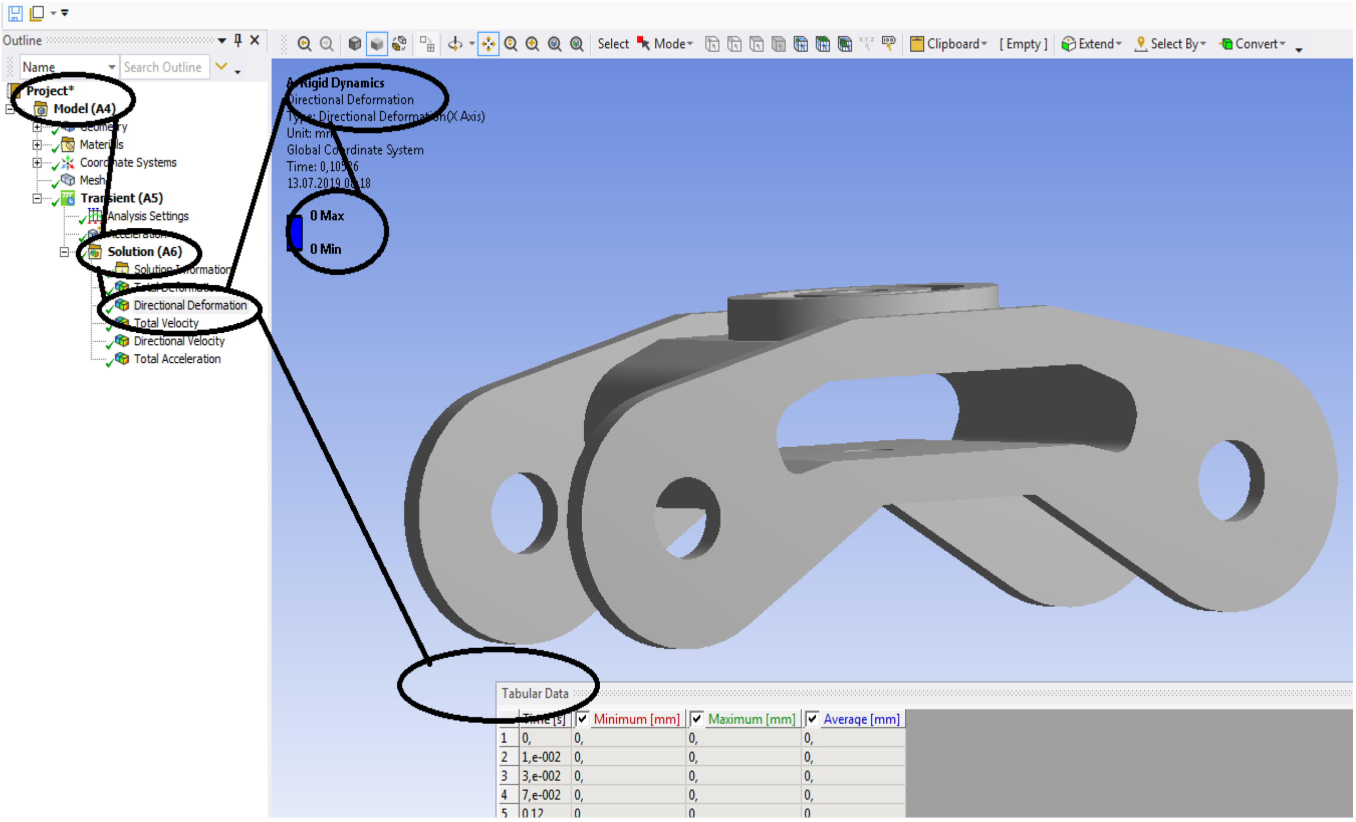


Figura 337 - Deformații direcționale pe axa x [mm]

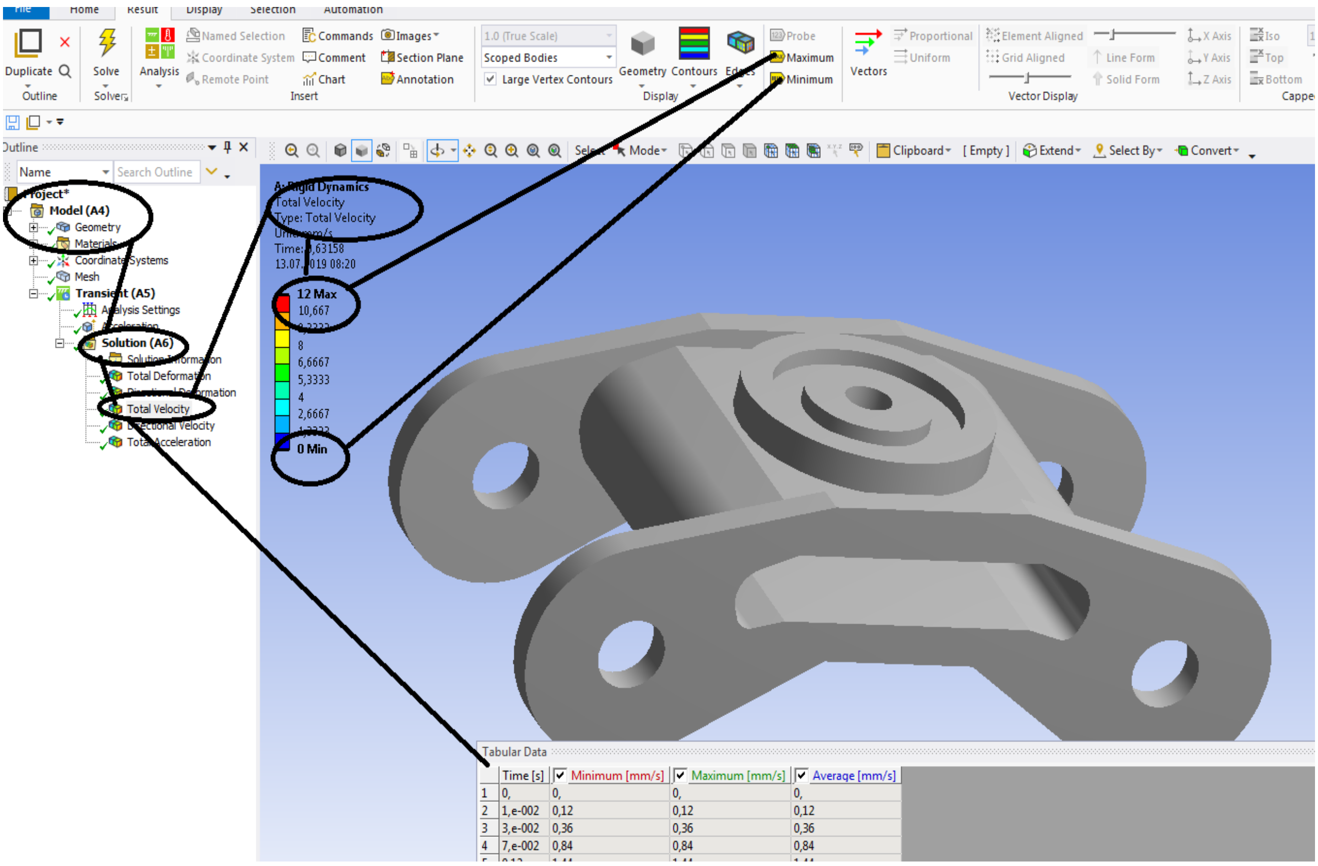


Figura 338– Vitezele totale [mm/s]

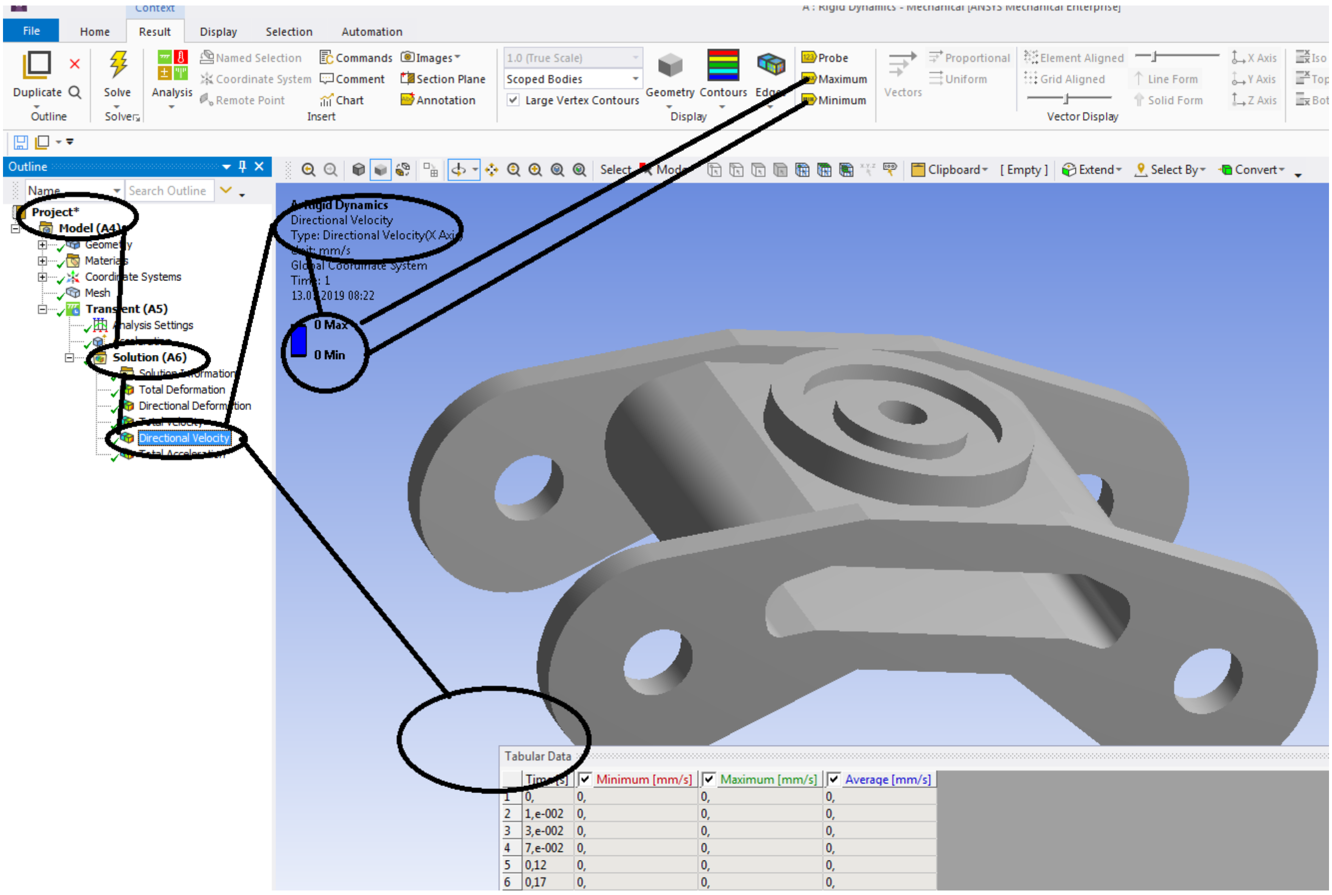


Figura 339 – Vitezele dupa axa OX [mm/s]

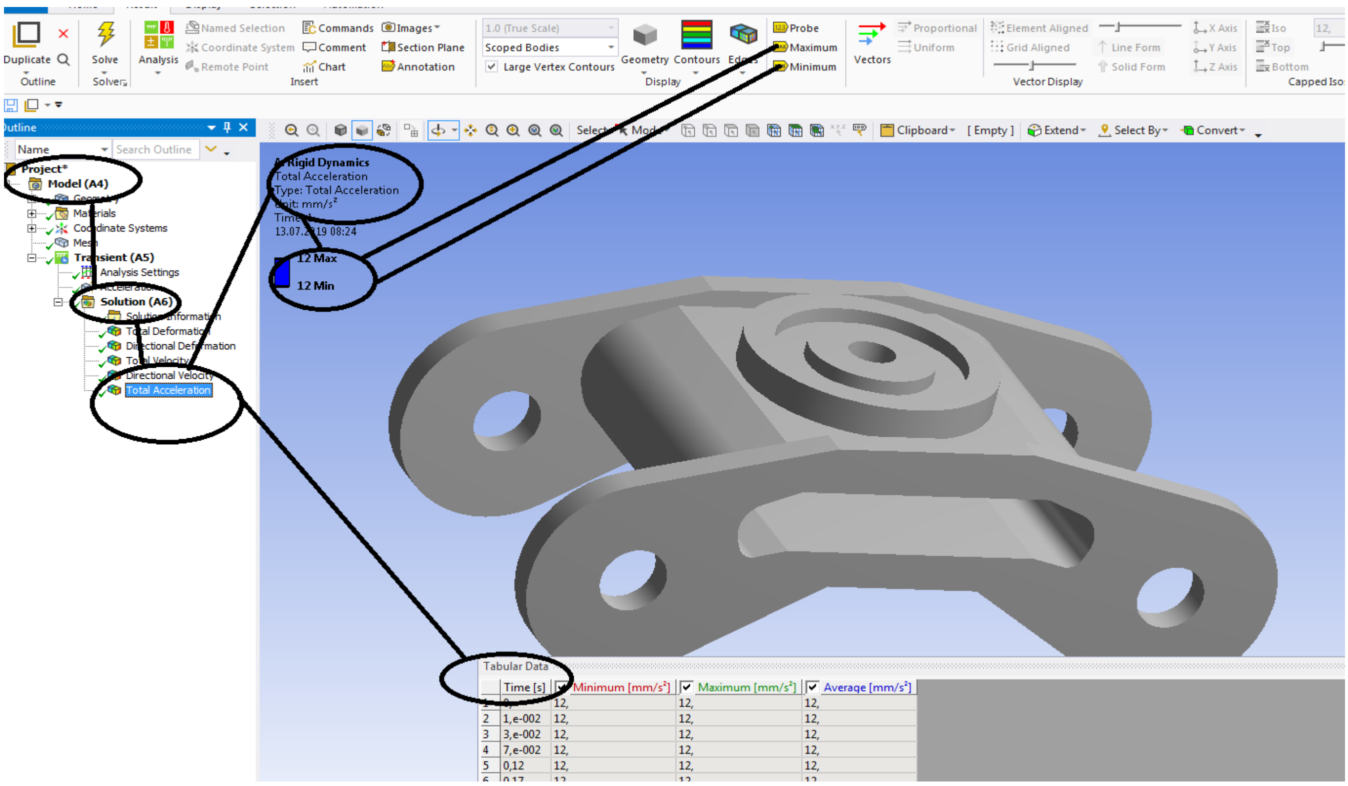


Figura 340 – Acceleratiile totale [mm/s^2]

Rigid dynamics

7.4 Boghiu vagon cale ferata- Acceleratia numai pe axa OZ

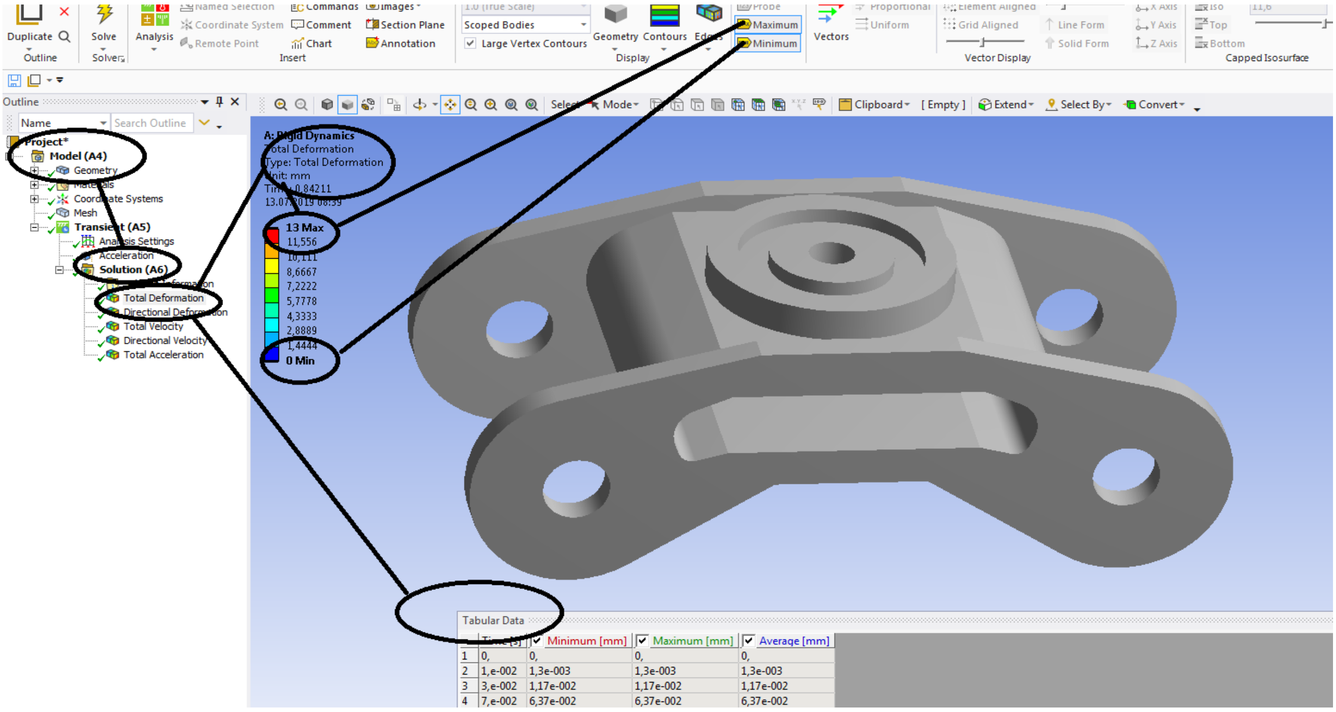


Figura 341 - Deformații totale [mm]

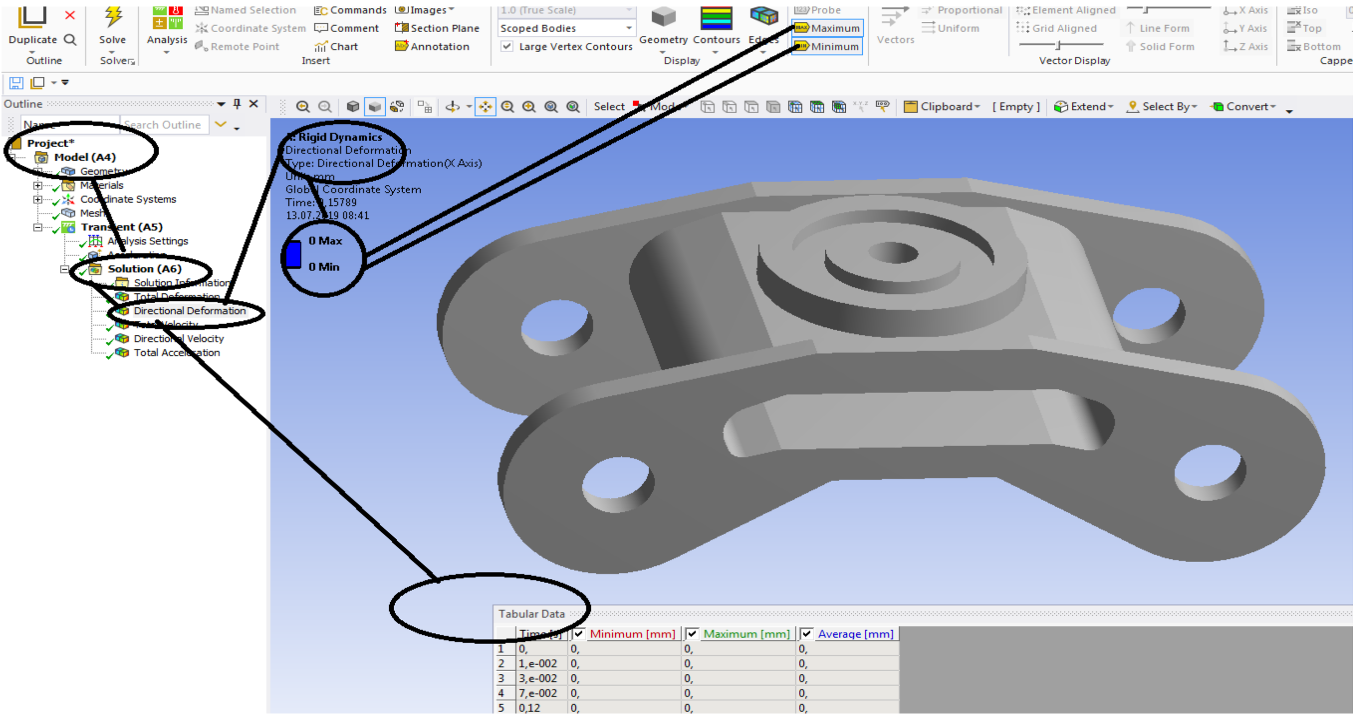


Figura 342 - Deformații direcționale pe axa x [mm]

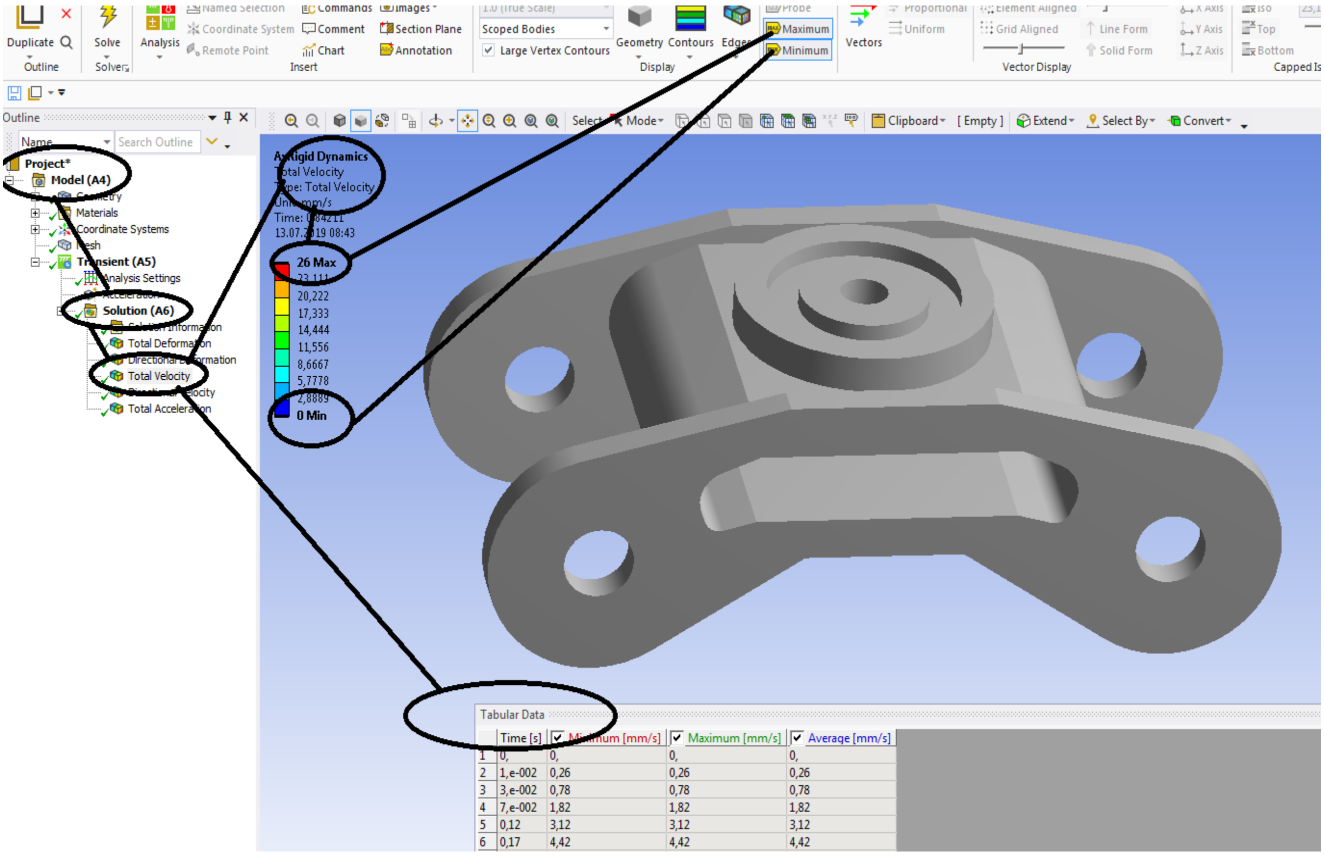


Figura 343 – Vitezele totale [mm/s]

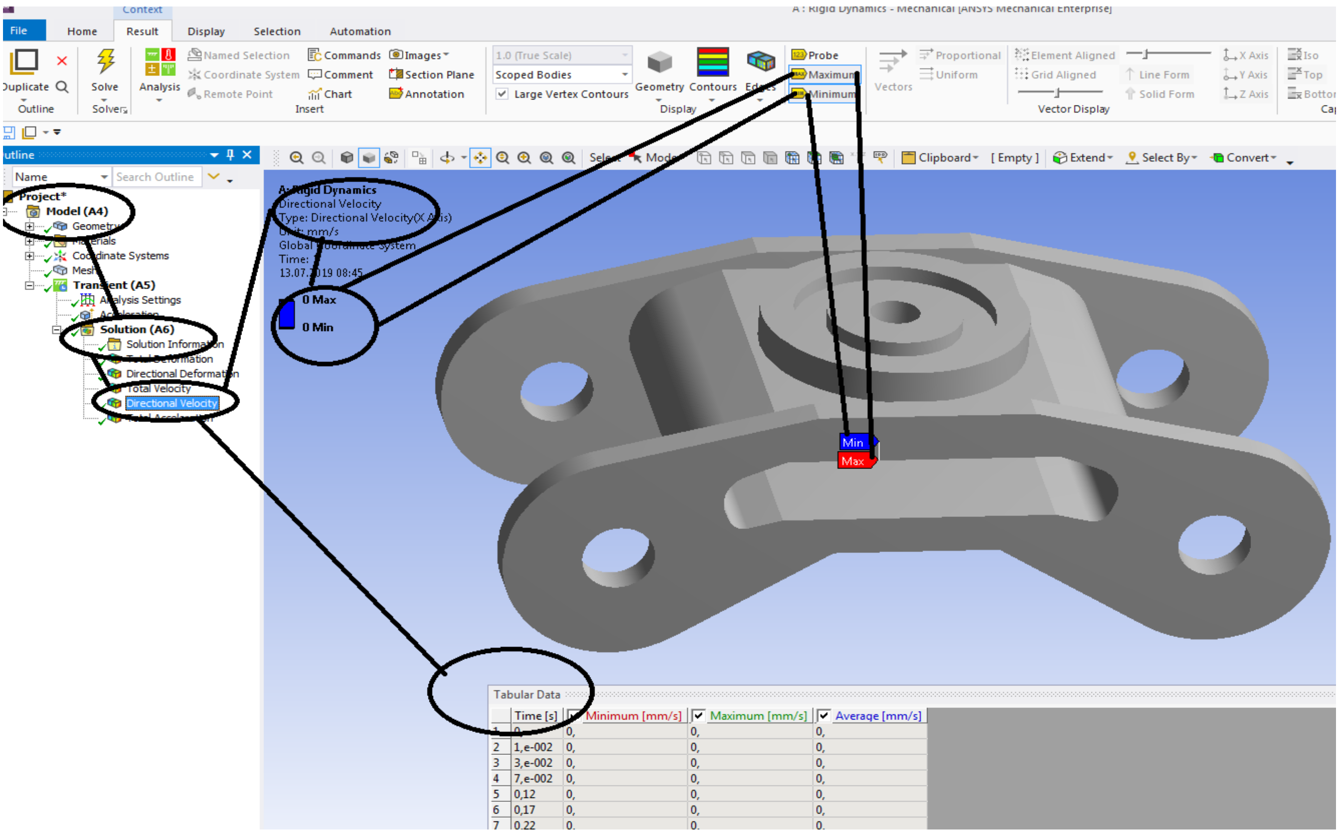


Figura 344 - Vitezele dupa axa OX [mm/s]

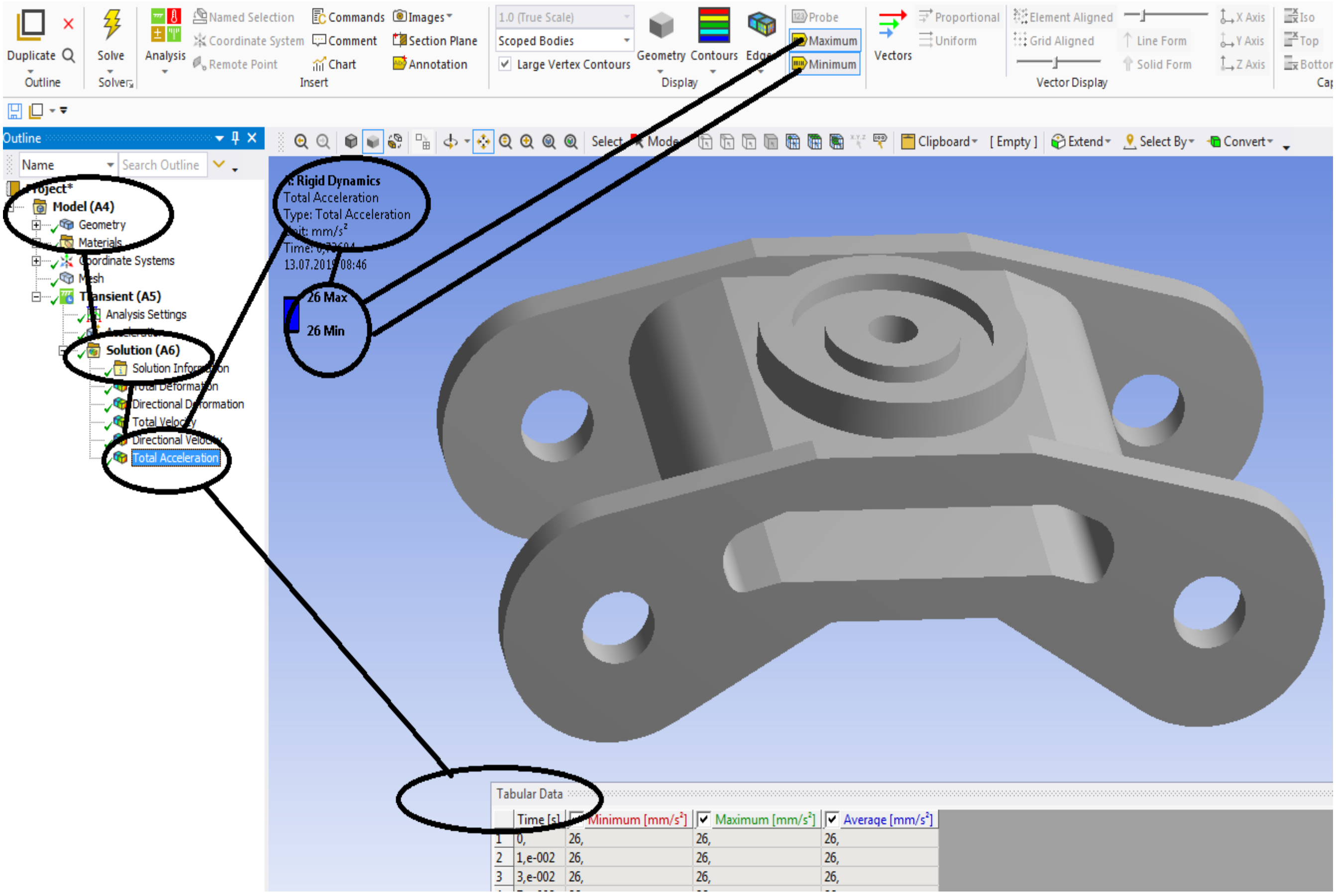


Figura 345 – Acceleratiile totale [mm/s^2]

Rigid dynamics

7.5 Vagon cale ferata- Acceleratia totala pe toate axele de coordonate

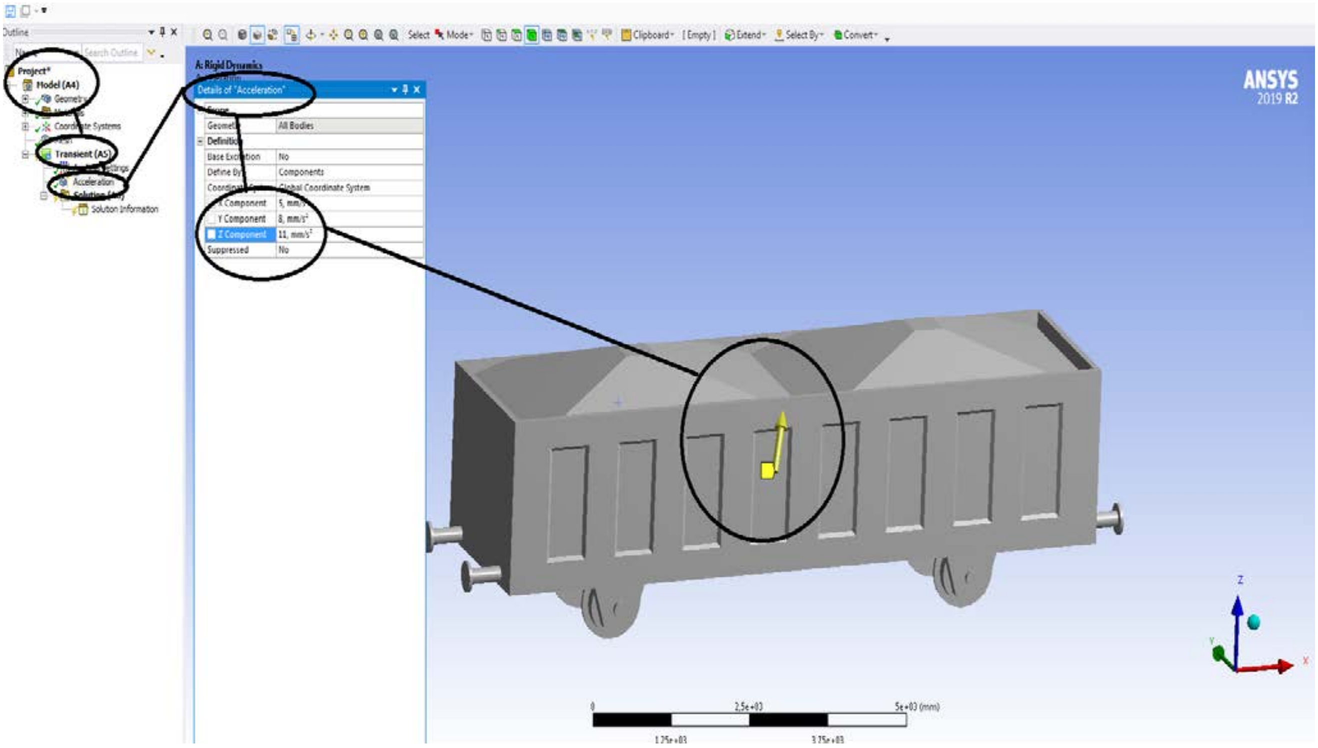


Figura 346 – Acceleratia totala [mm/s^2]

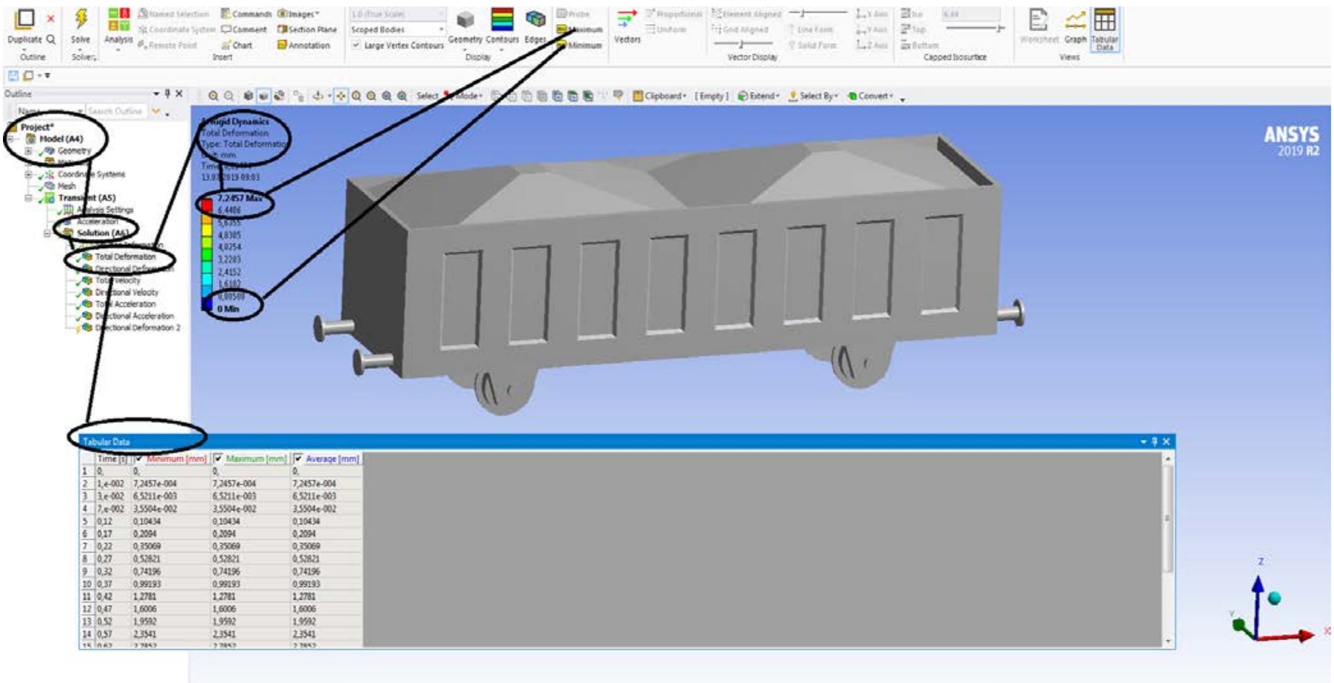


Figura 347 - Deformații totale [mm]

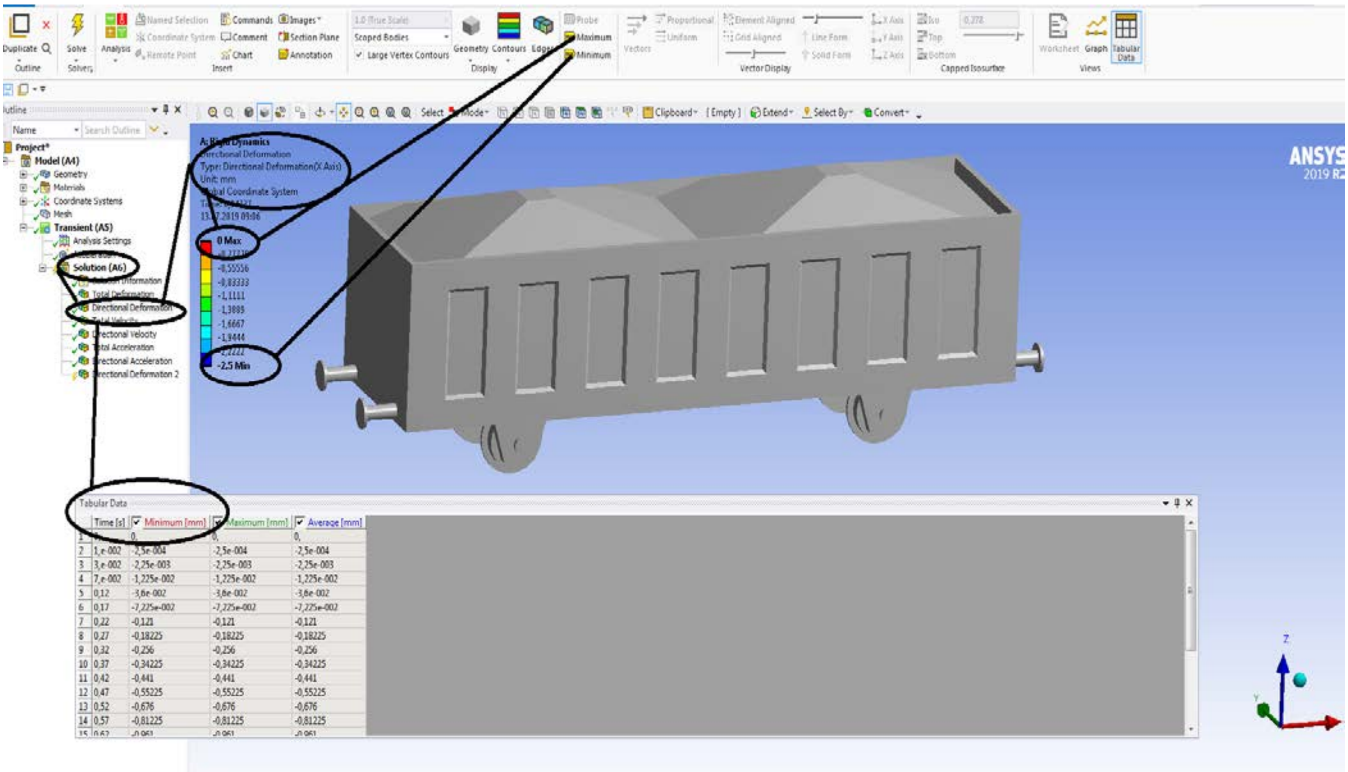


Figura 348 - Deformații direcționale pe axa x [mm]

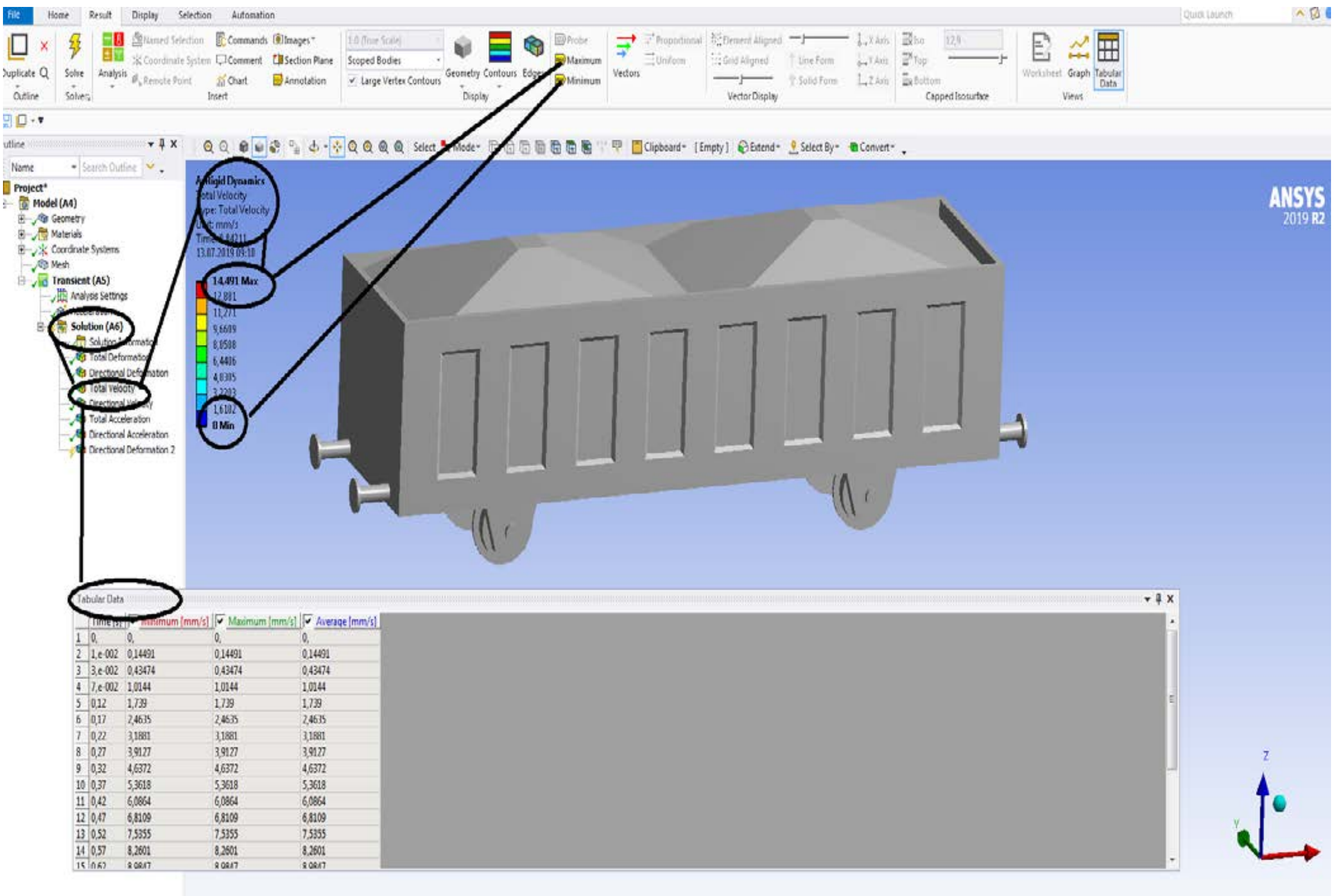


Figura 349– Vitezele totale [mm/s]

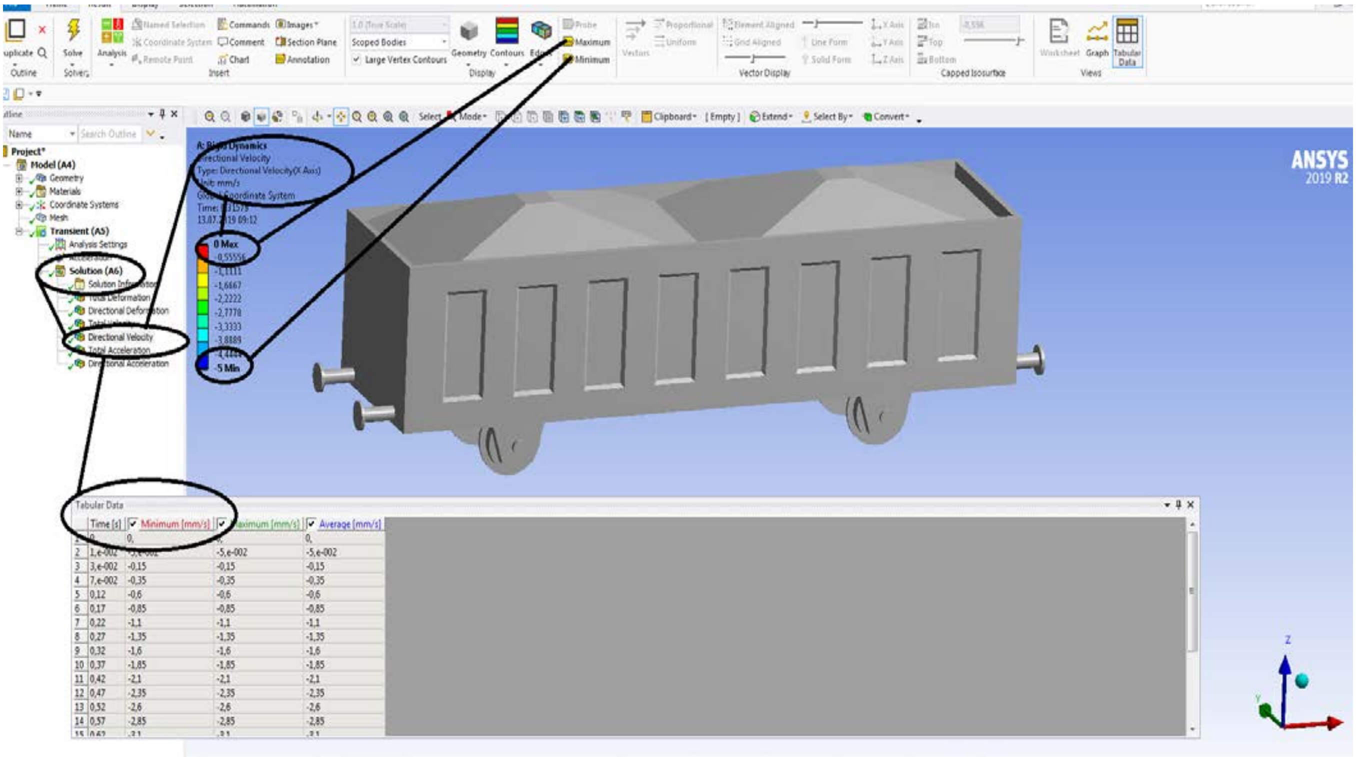


Figura 350 – Vitezele dupa axa OX [mm/s]

Rigid dynamics

7.6 Vagon cale ferata- Acceleratia pe axa OX

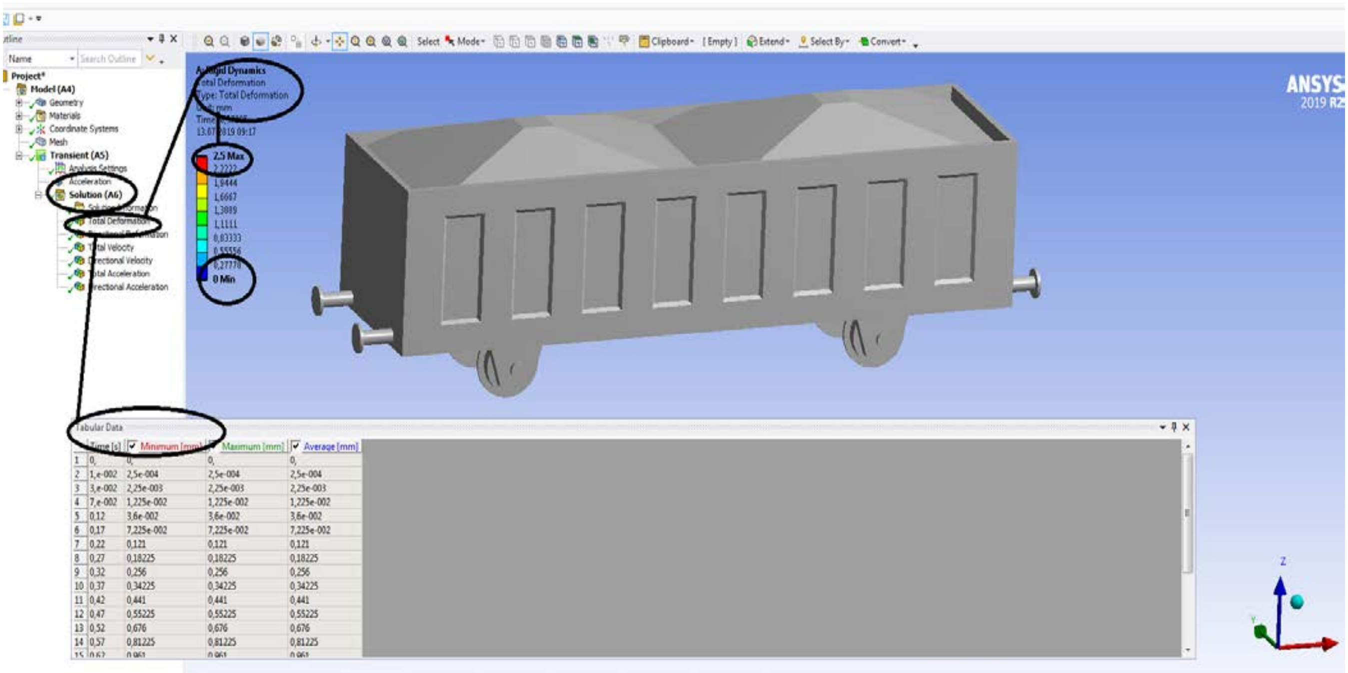


Figura 351 - Deformații totale [mm]

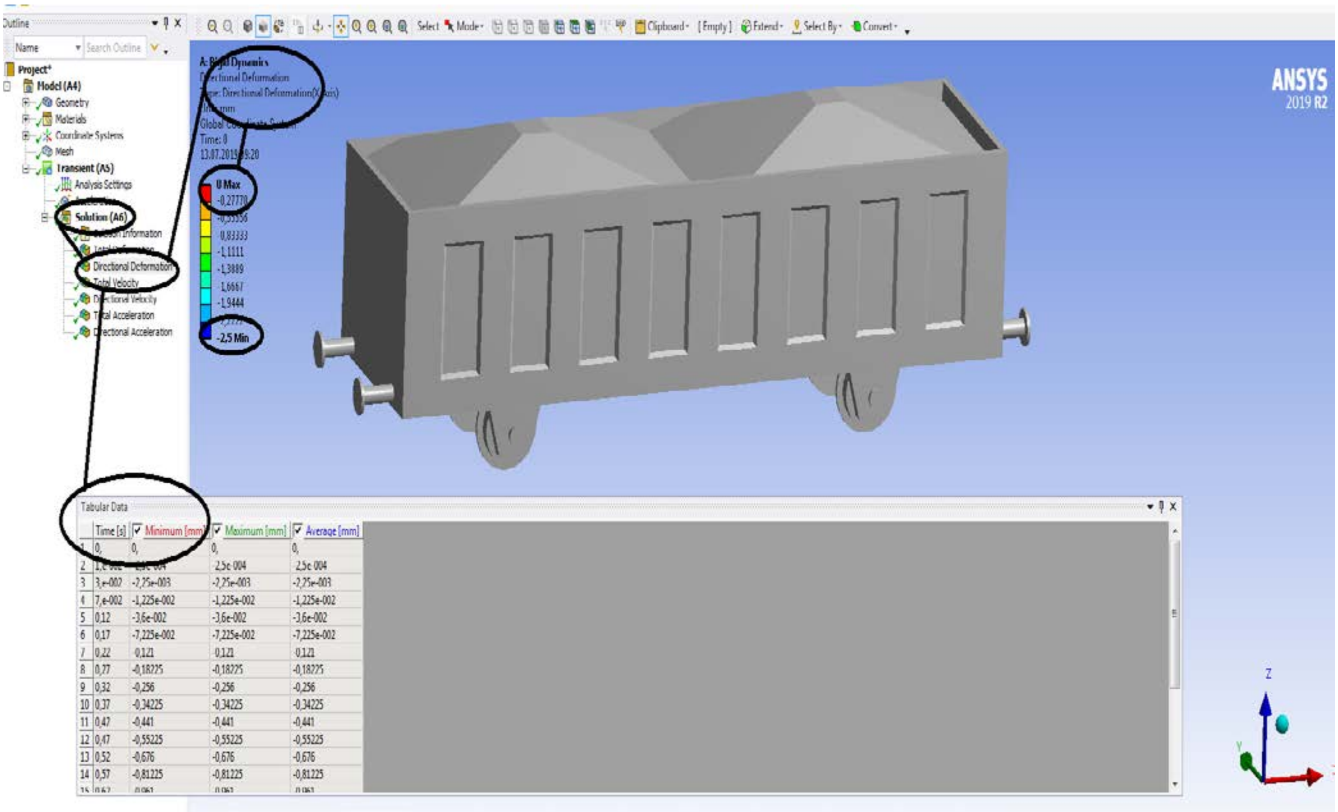


Figura 352 - Deformații direcționale pe axa x [mm]

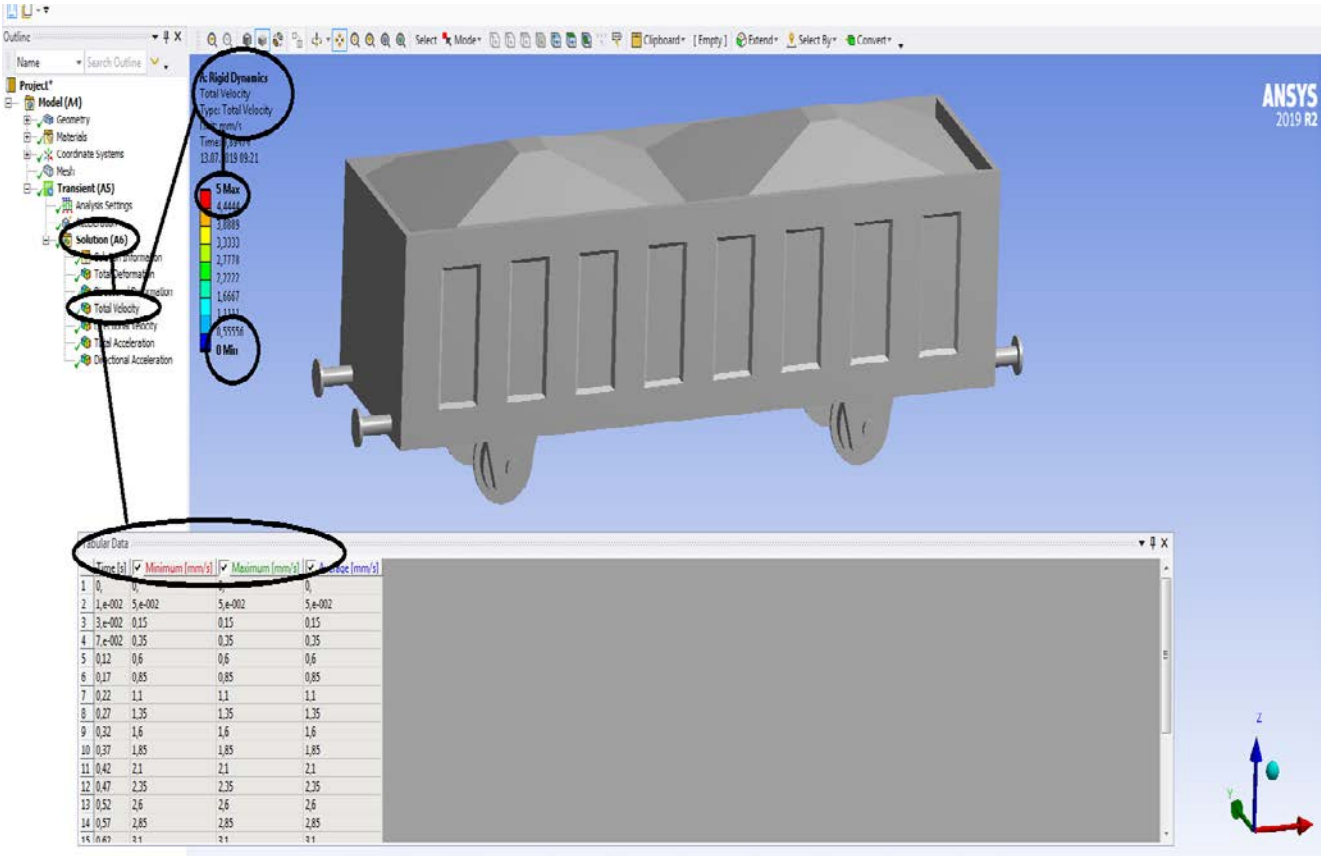


Figura 353 – Vitezele totale [mm/s]

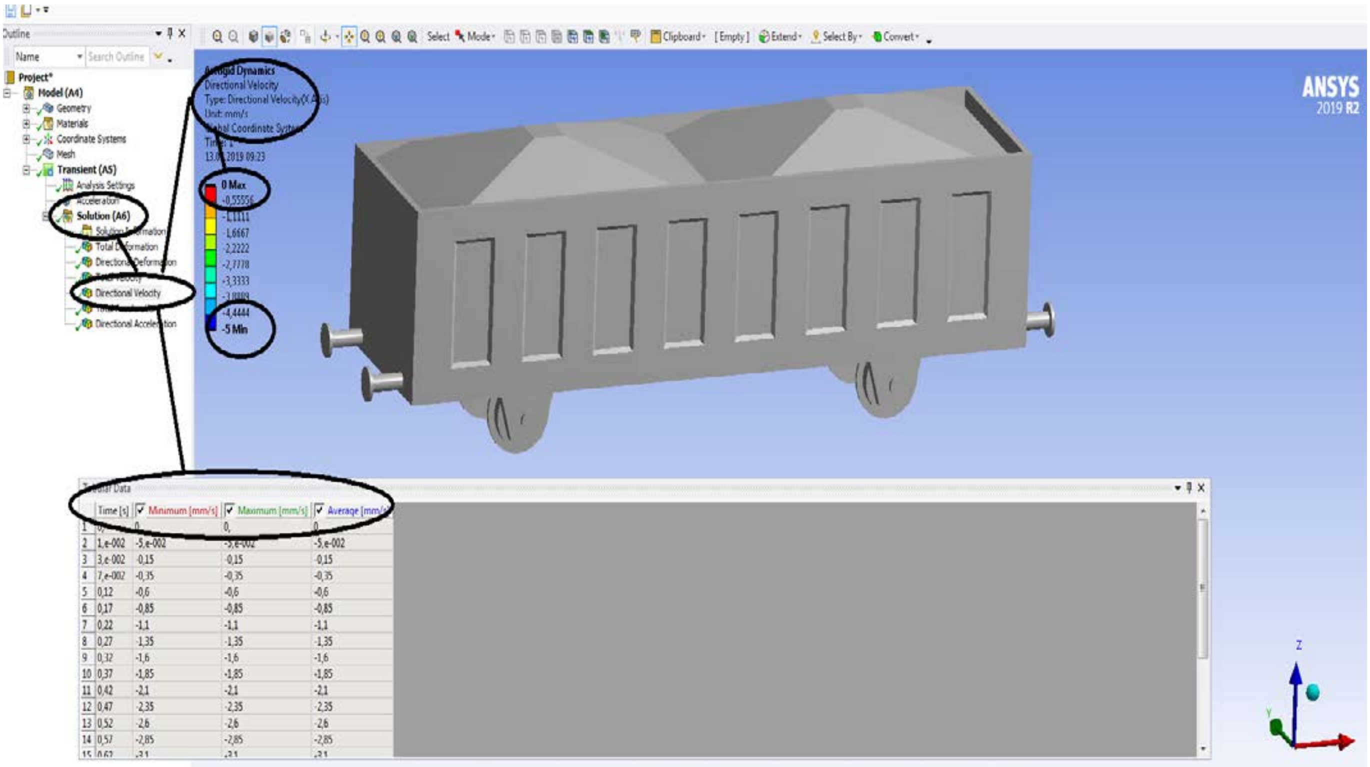


Figura 354 – Vitezele dupa axa OX [mm/s]

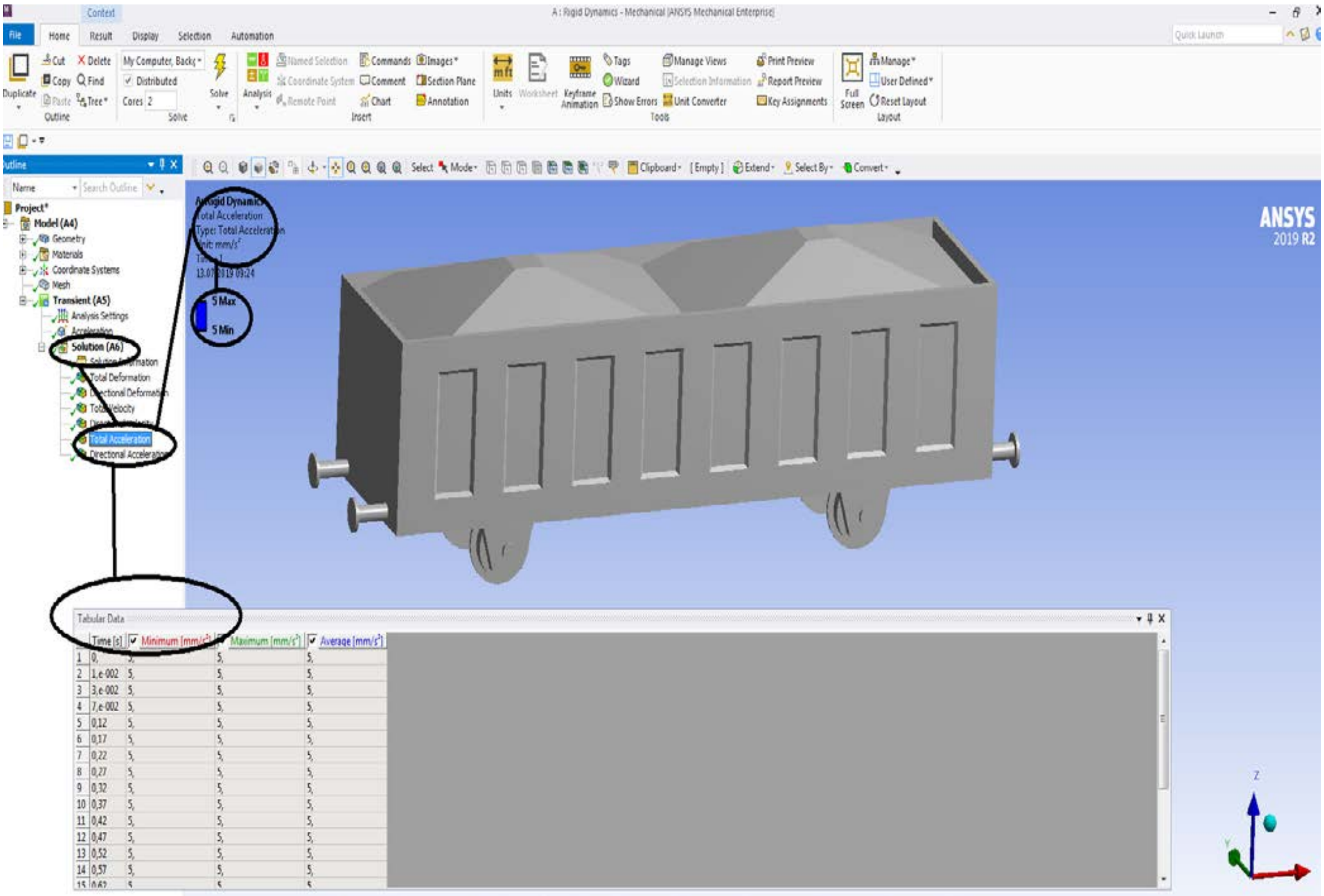


Figura 355 – Acceleratiile totale [mm/s^2]

Rigid dynamics

7.7 Vagon cale ferata- Acceleratia pe axa OY

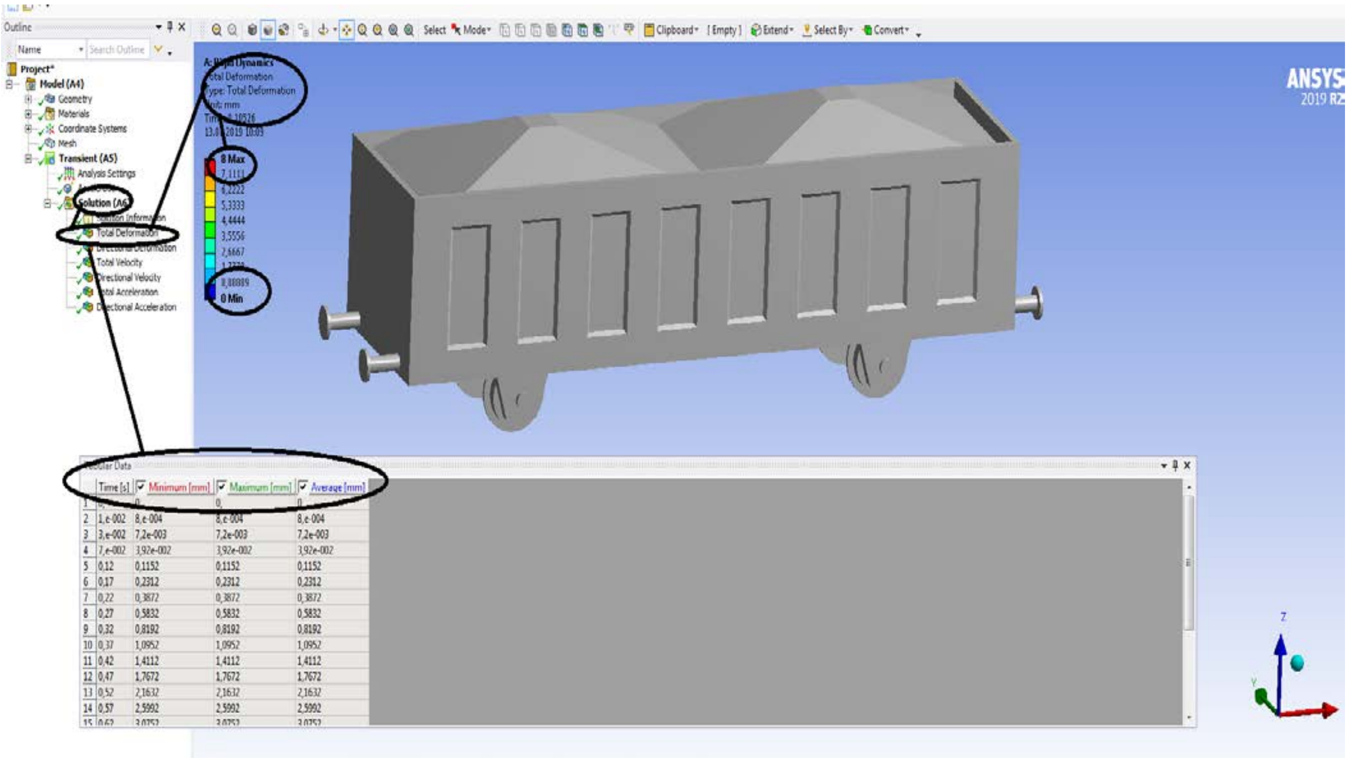


Figura 356 - Deformații totale [mm]

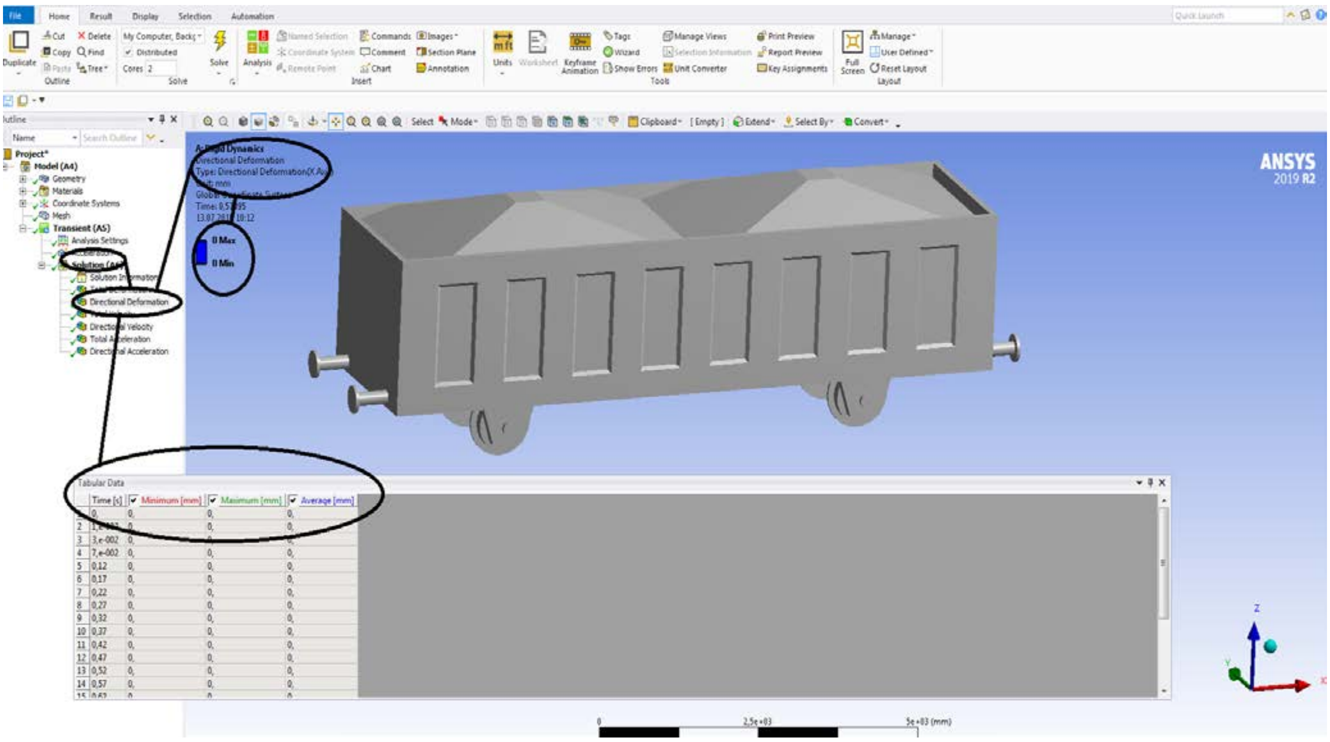


Figura 357 - Deformații direcționale pe axa x [mm]

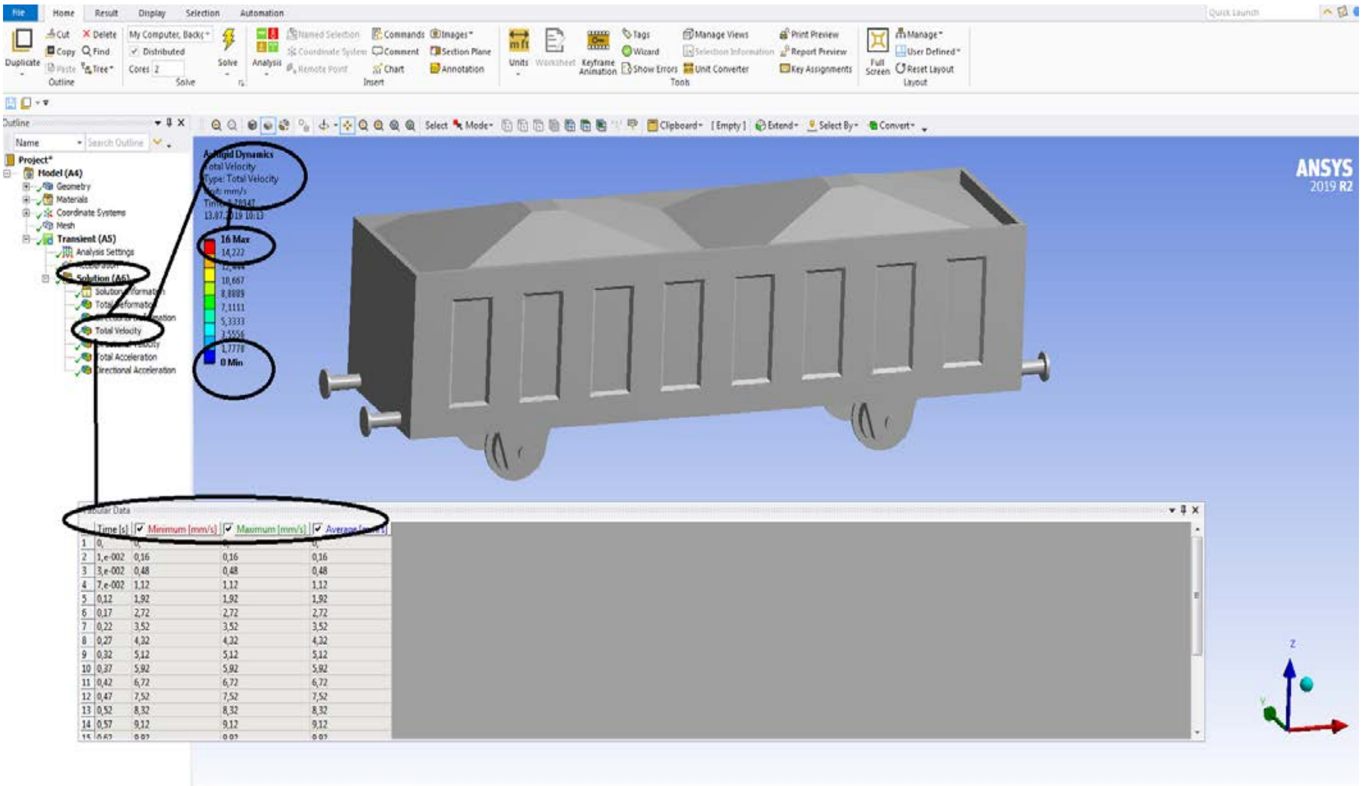


Figura 358 – Vitezele totale [mm/s]

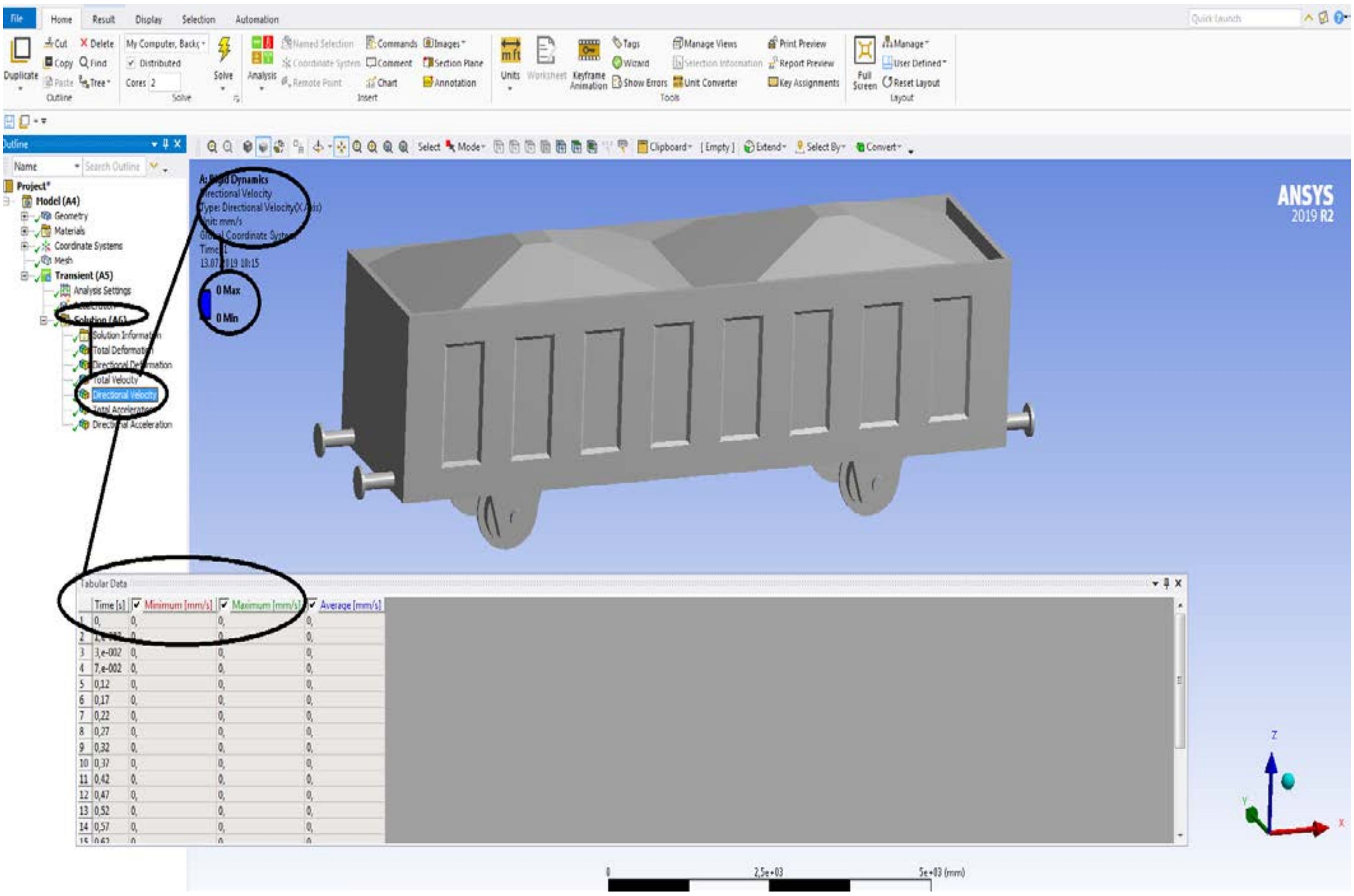


Figura 359 – Vitezele dupa axa OX [mm/s]

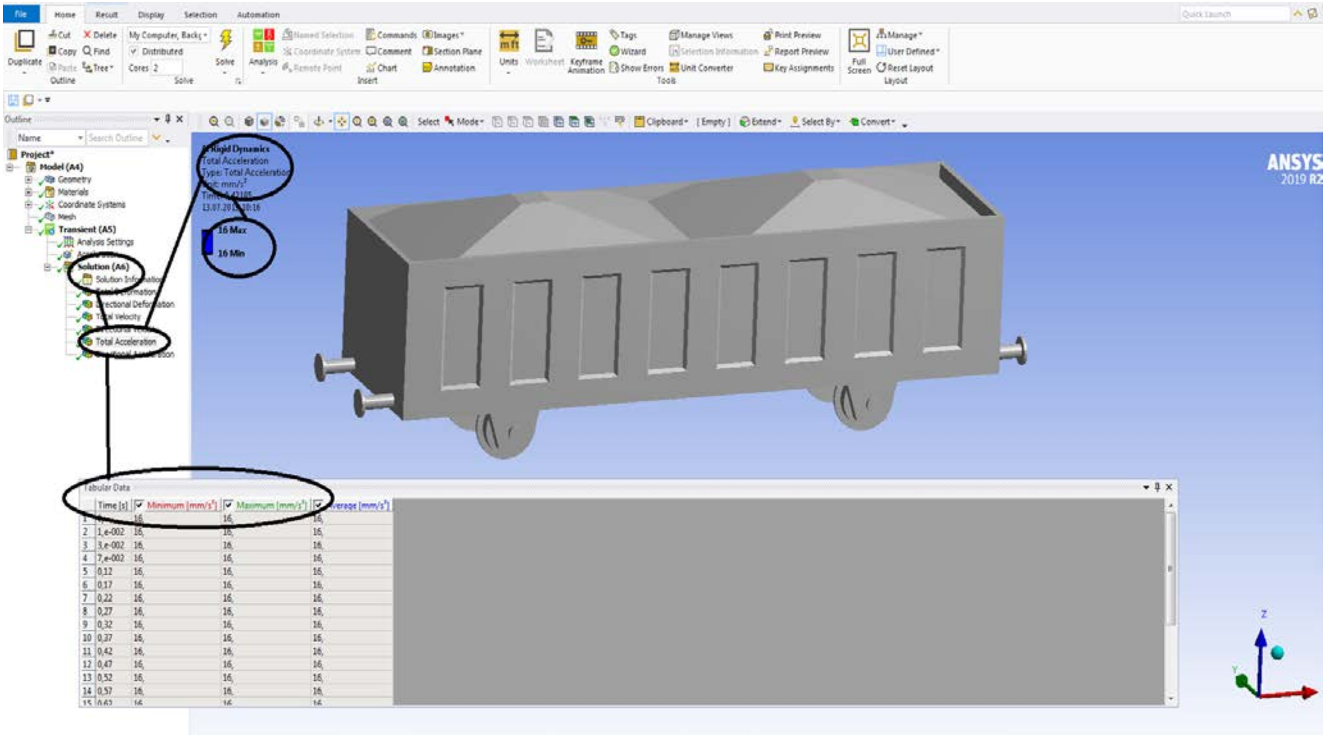


Figura 360 – Acceleratiile totale [mm/s^2]

Rigid dynamics

7.8 Vagon cale ferata- Acceleratia pe axa OZ

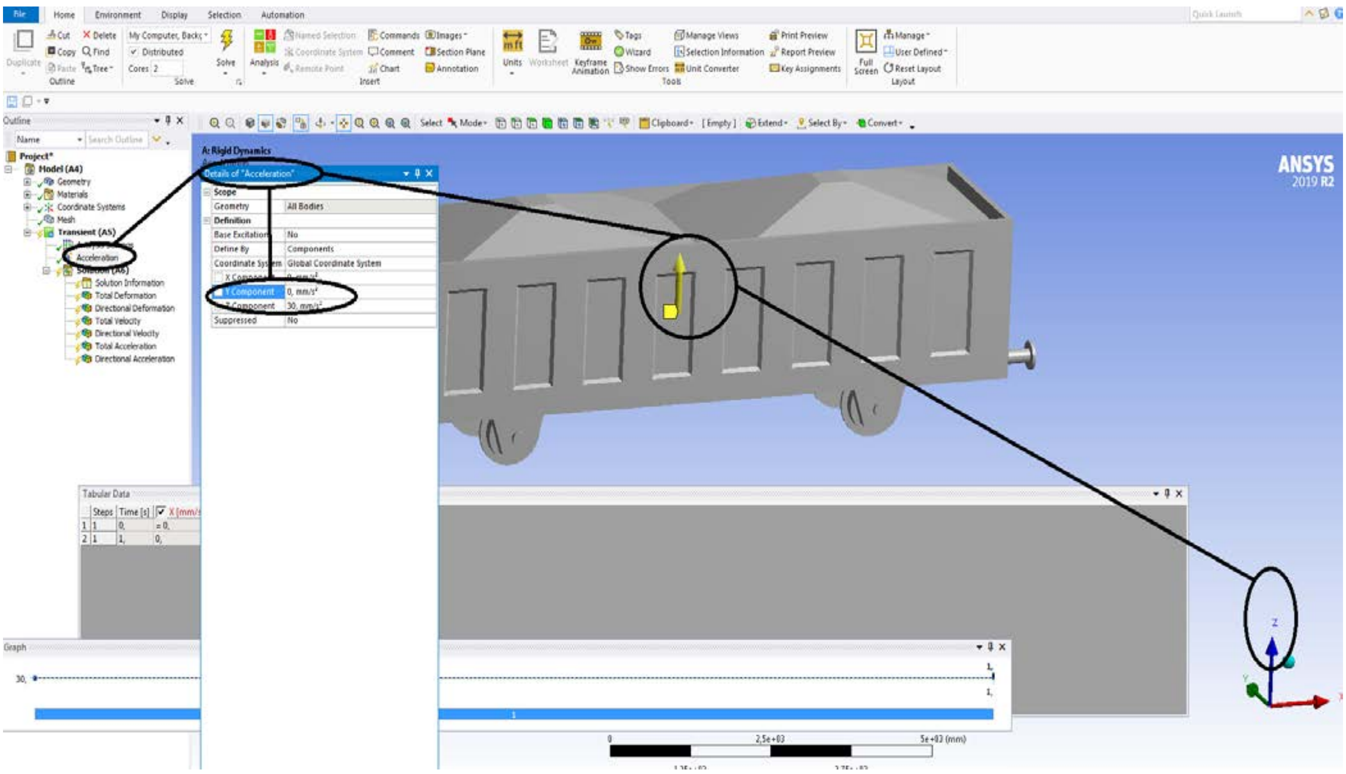


Figura 361 – Acceleratia dupa axa OZ

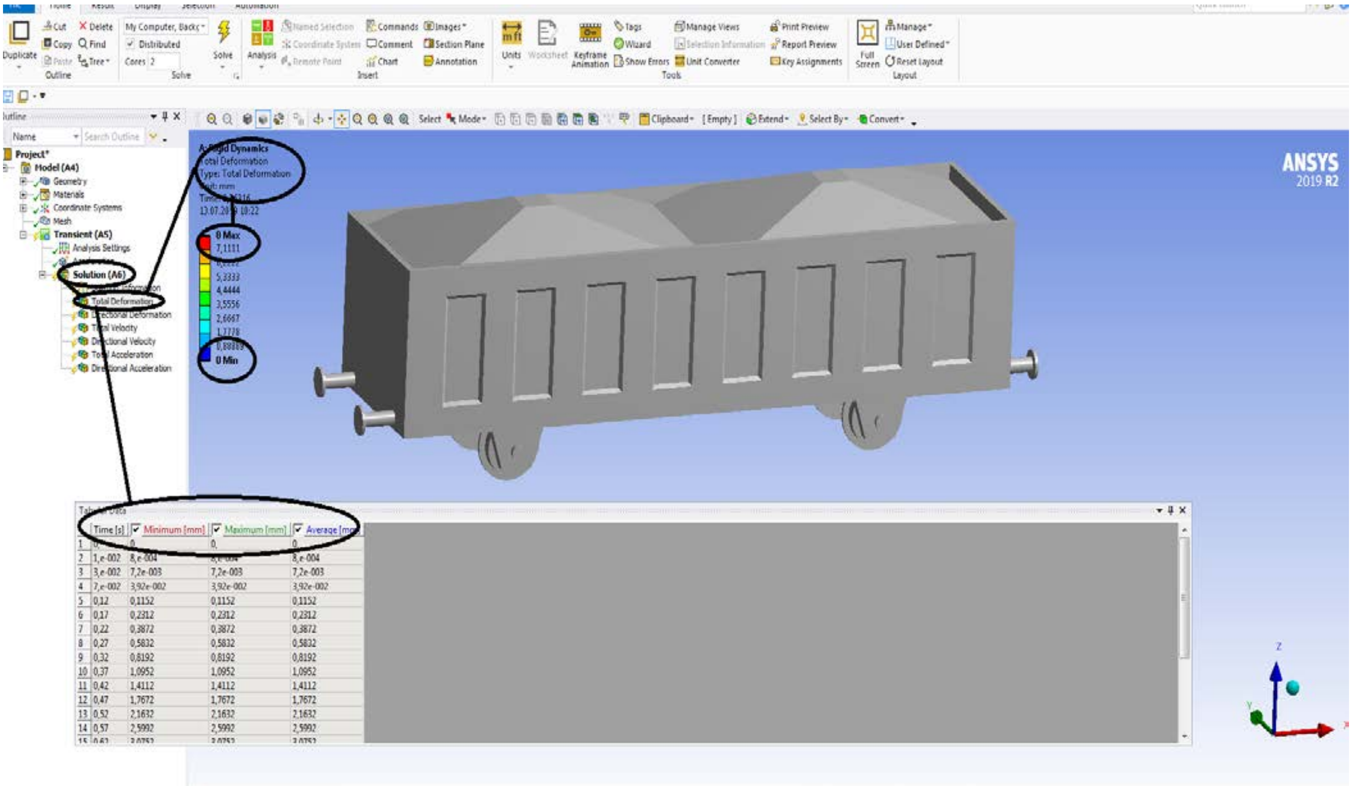


Figura 362 - Deformații totale [mm]

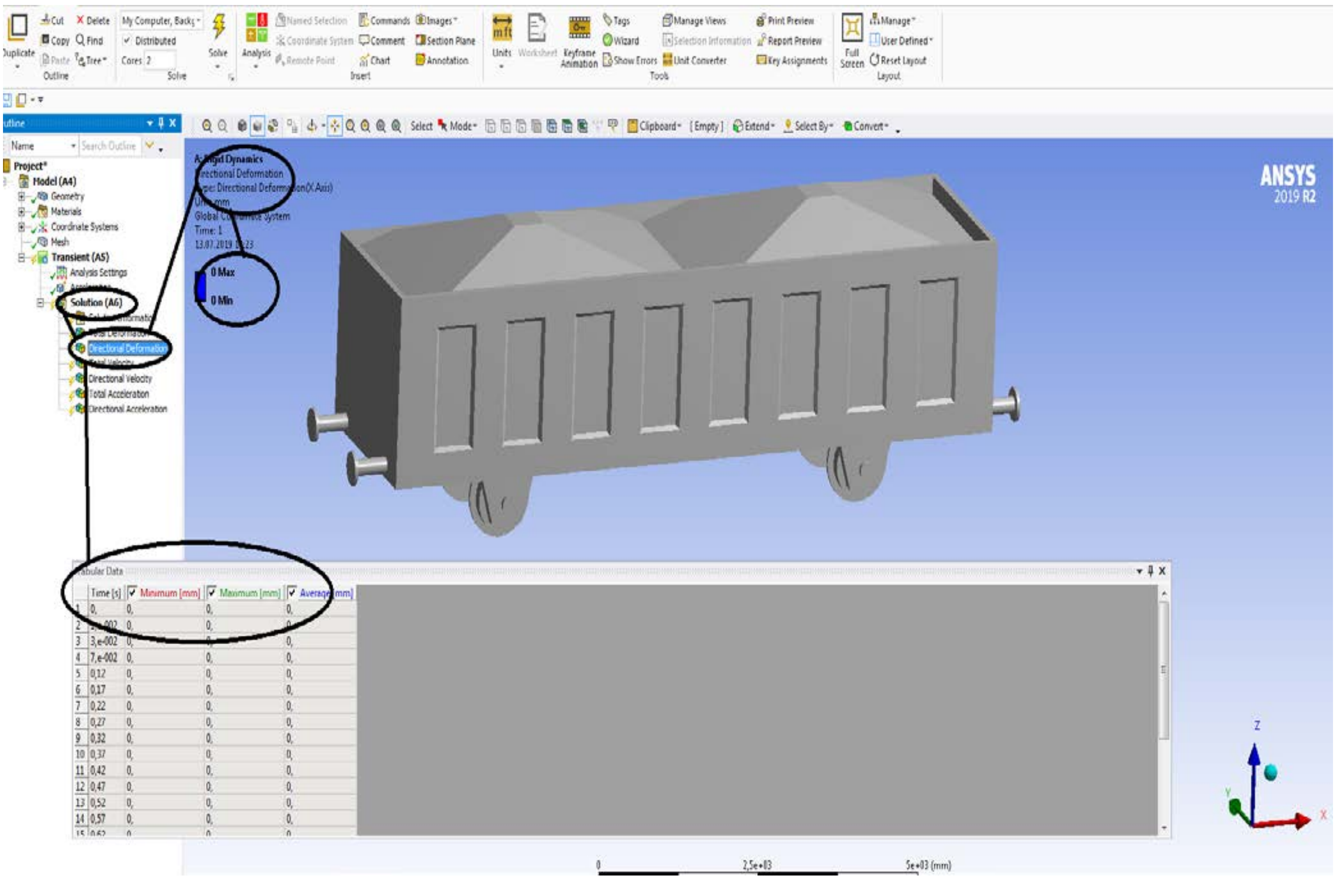


Figura 363 - Deformații direcționale pe axa x [mm]

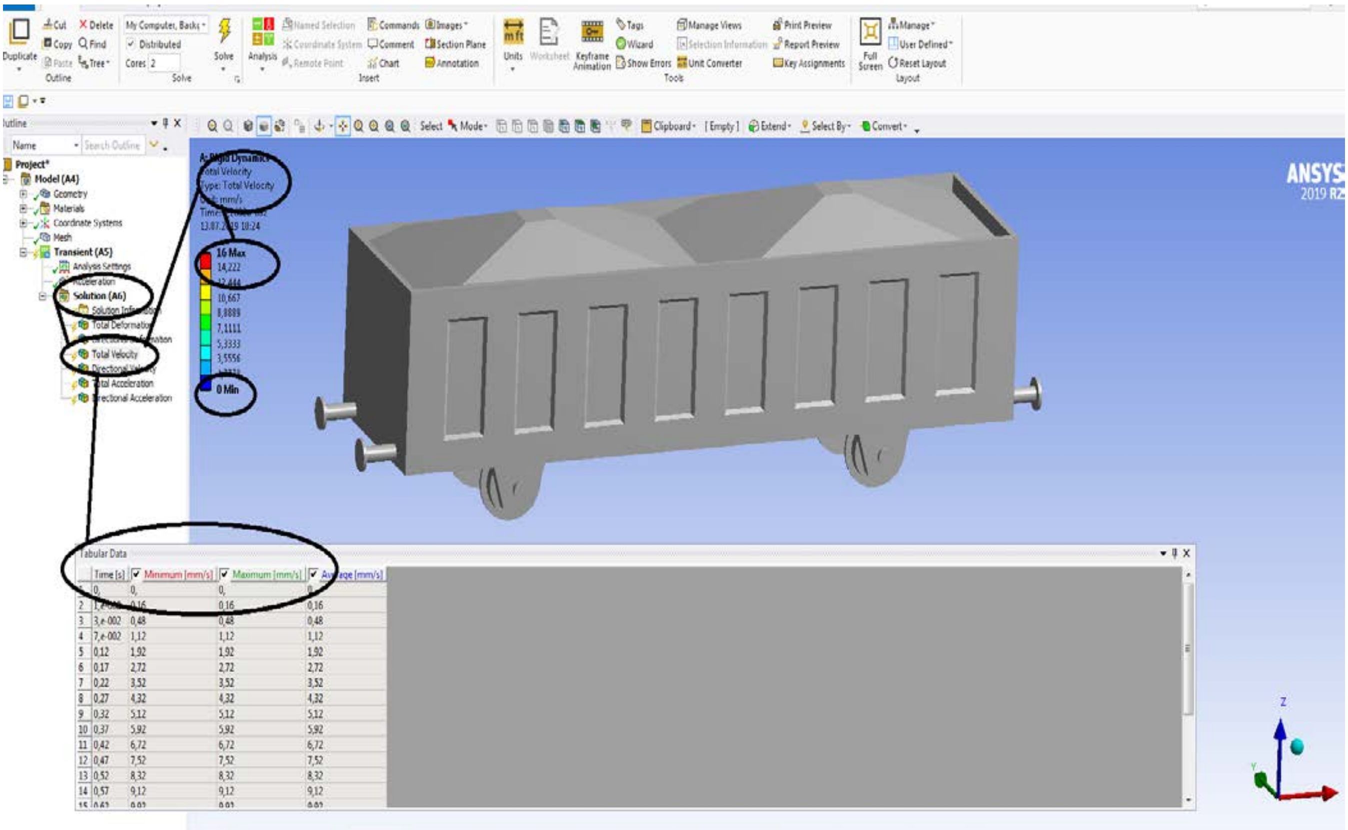


Figura 364 – Vitezele totale [mm/s]

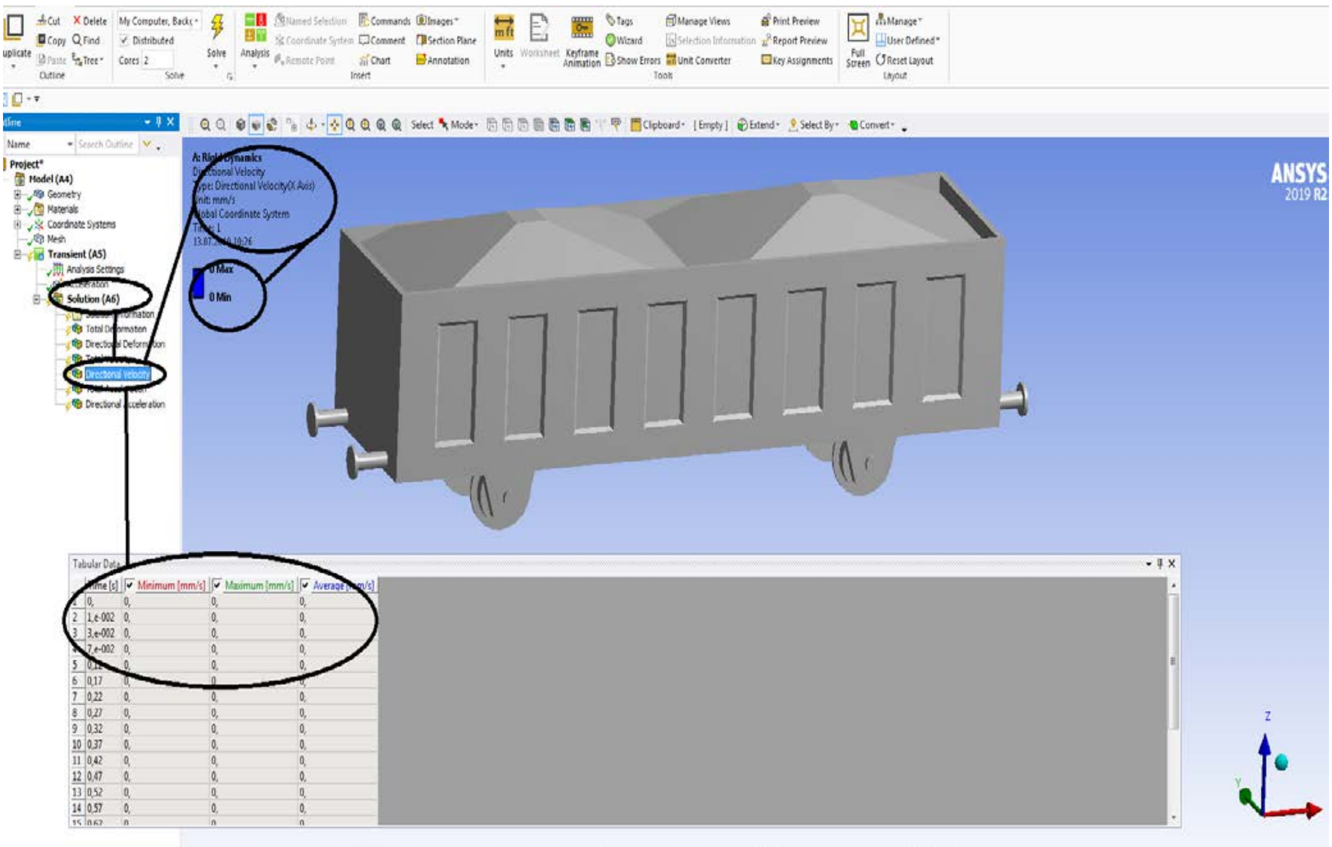


Figura 365 – Vitezele dupa axa OX [mm/s]

Rigid dynamics

7.9 Sasiu de vagon cale ferata- Acceleratia dupa toate axele de coordonate

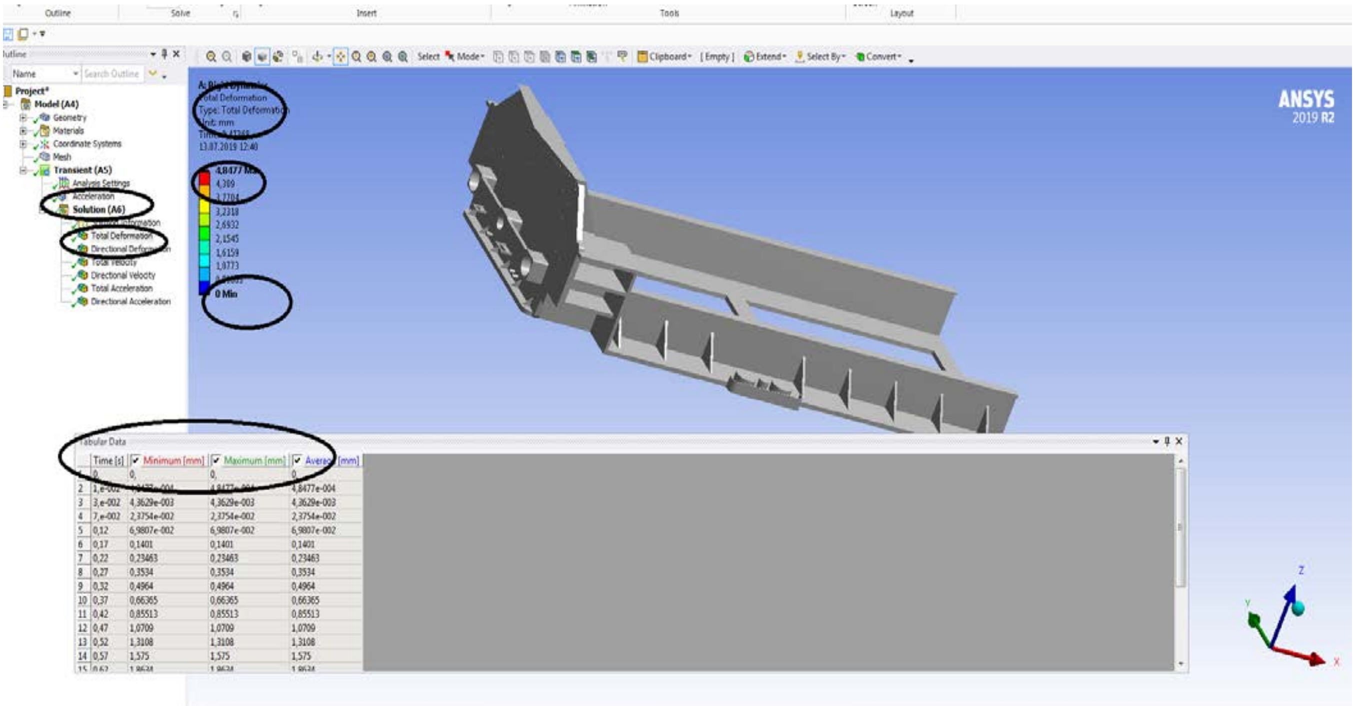


Figura 366 - Deformații totale [mm]

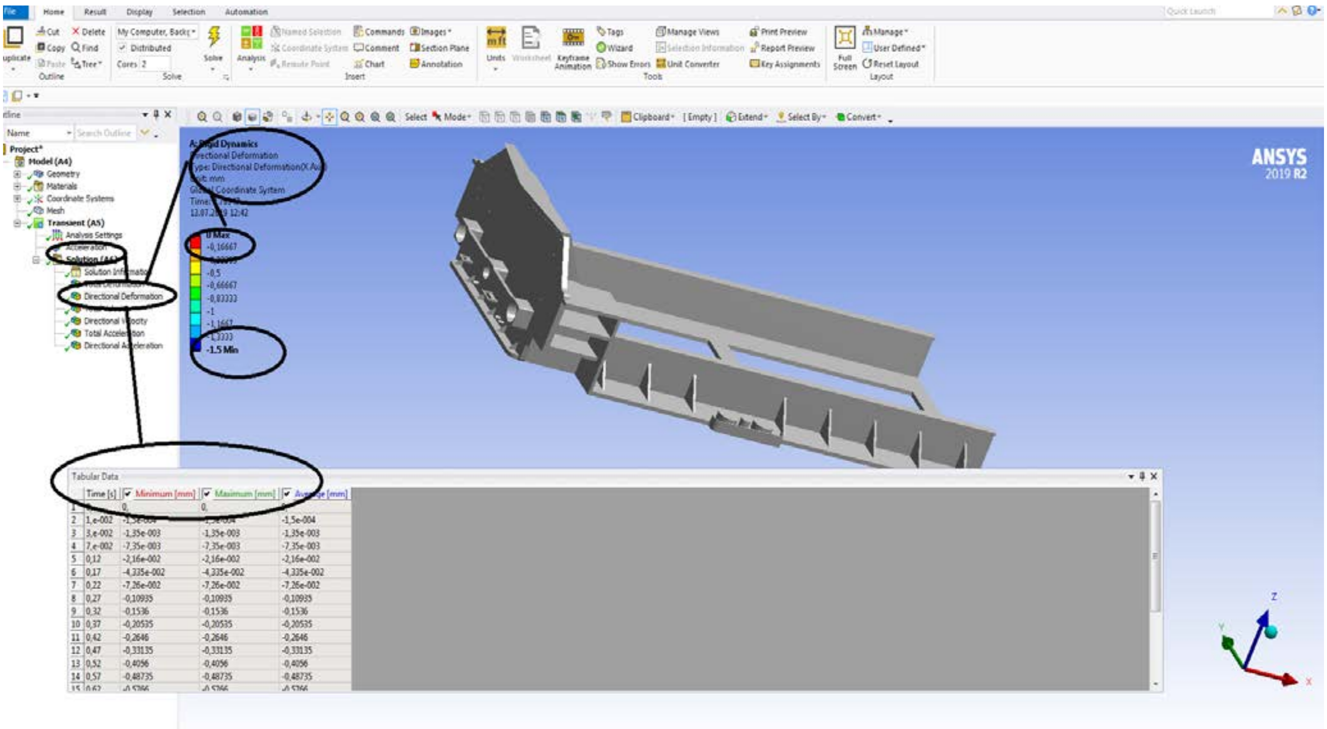


Figura 367 - Deformații direcționale pe axa x [mm]

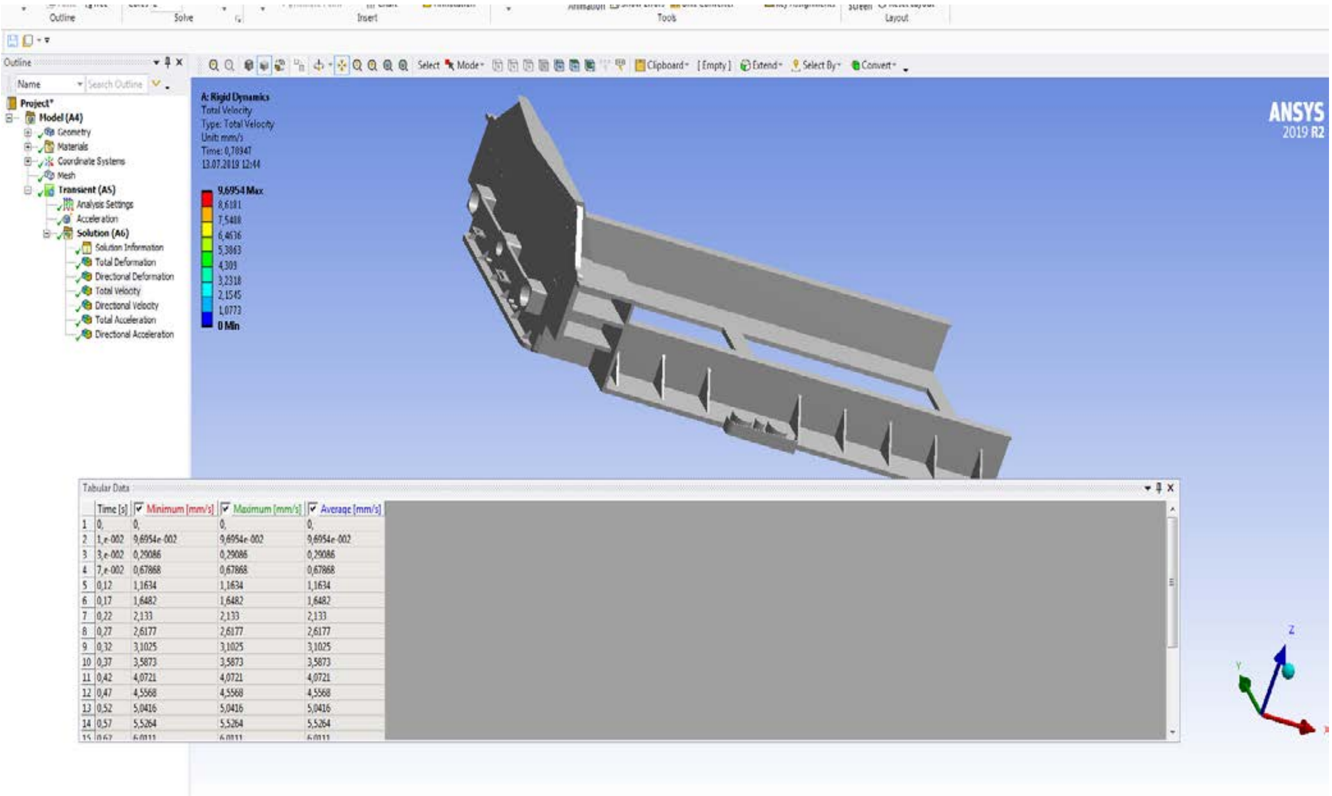


Figura 368 – Vitezele totale [mm/s]

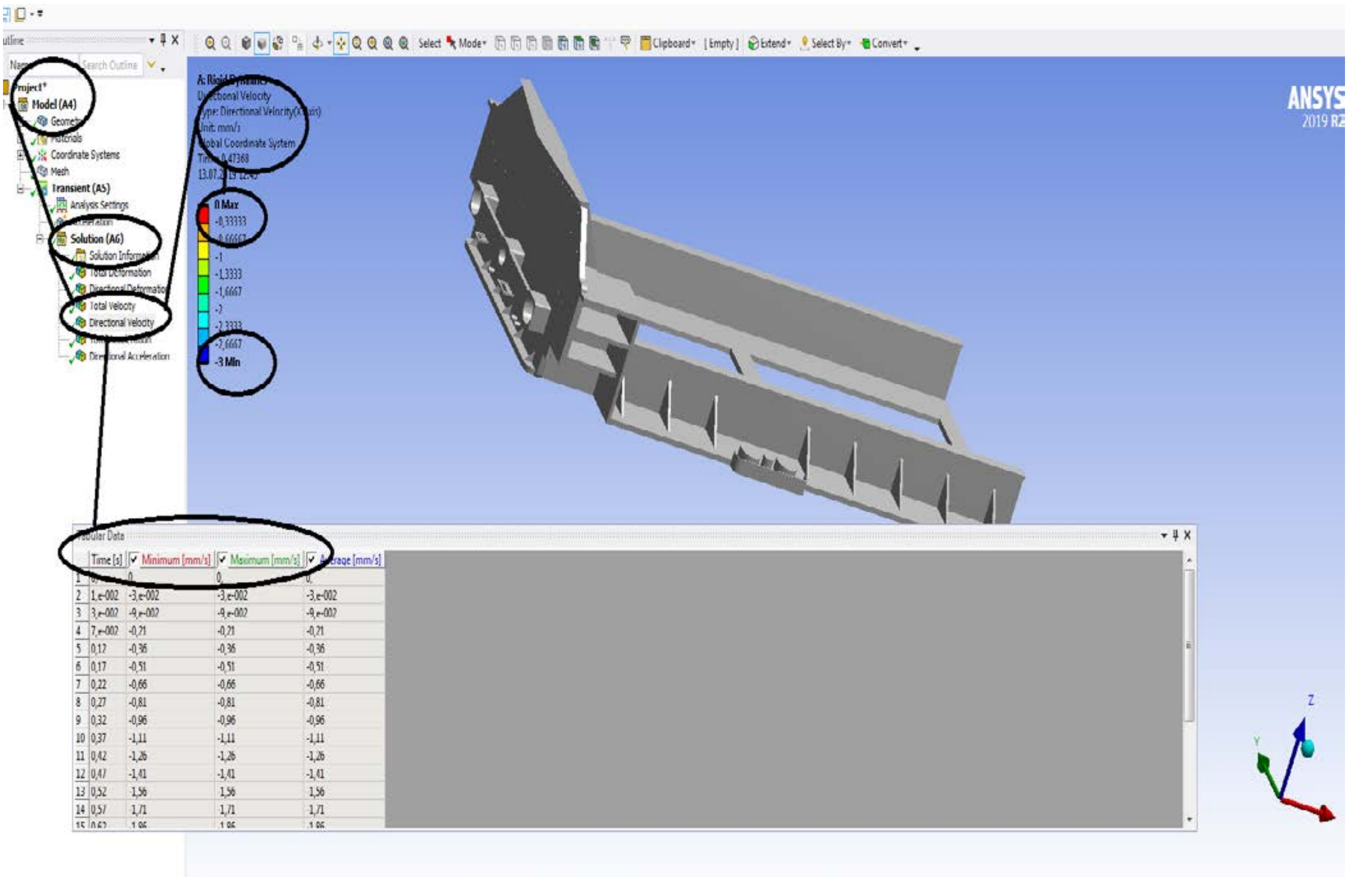


Figura 369 – Vitezele dupa axa OX [mm/s]

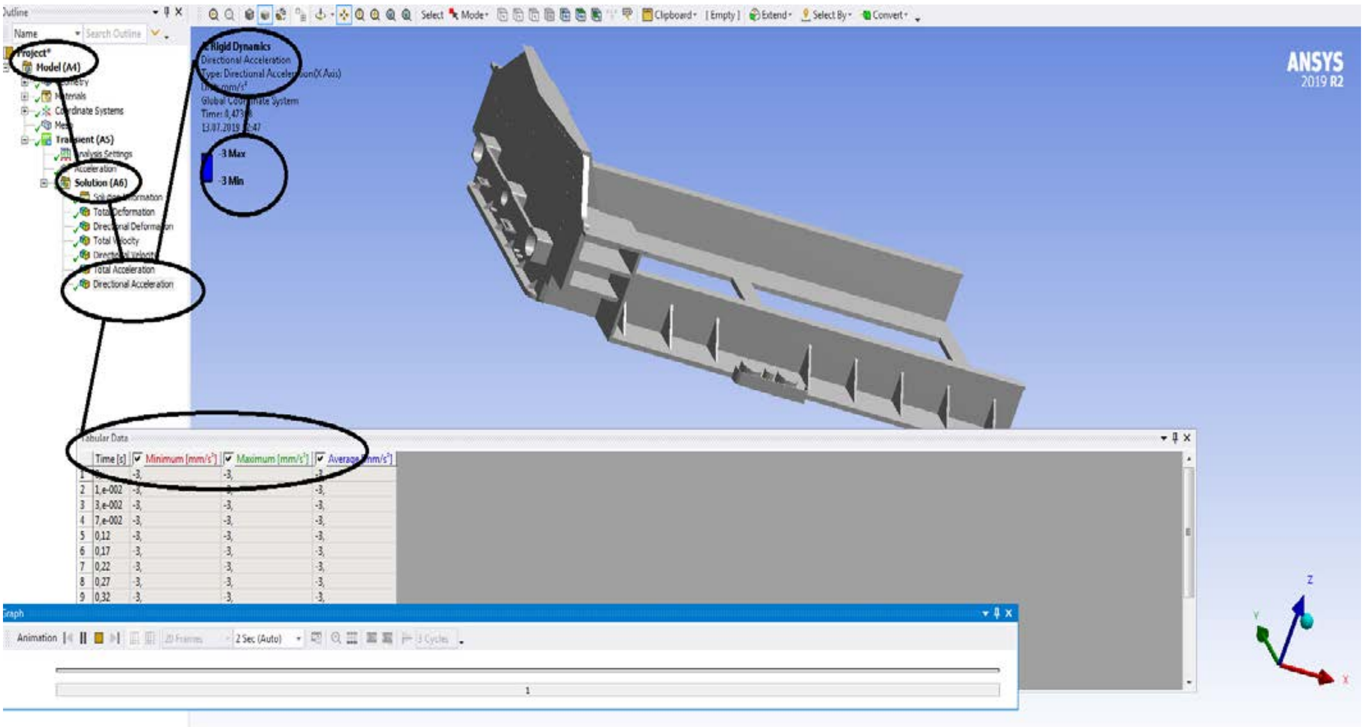


Figura 370– Acceleratiile dupa axa OX [mm/s^2]

Rigid dynamics

7.10 Sasiu de vagon cale ferata- Acceleratia dupa axa OX

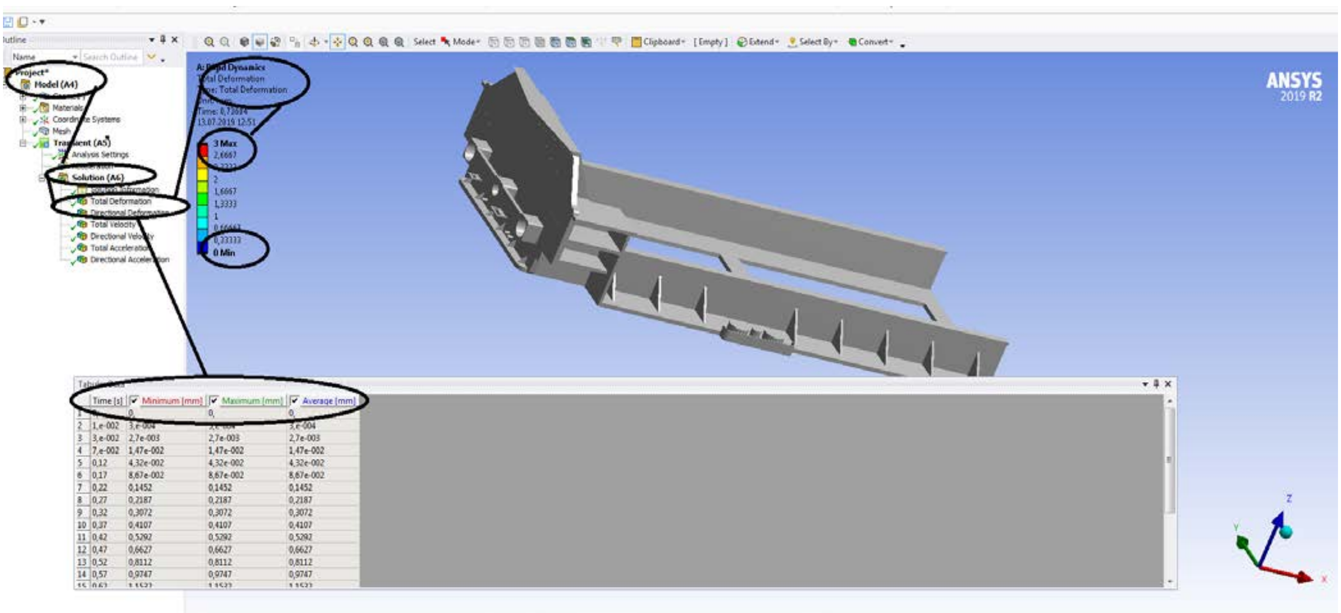


Figura 371 - Deformații totale [mm]

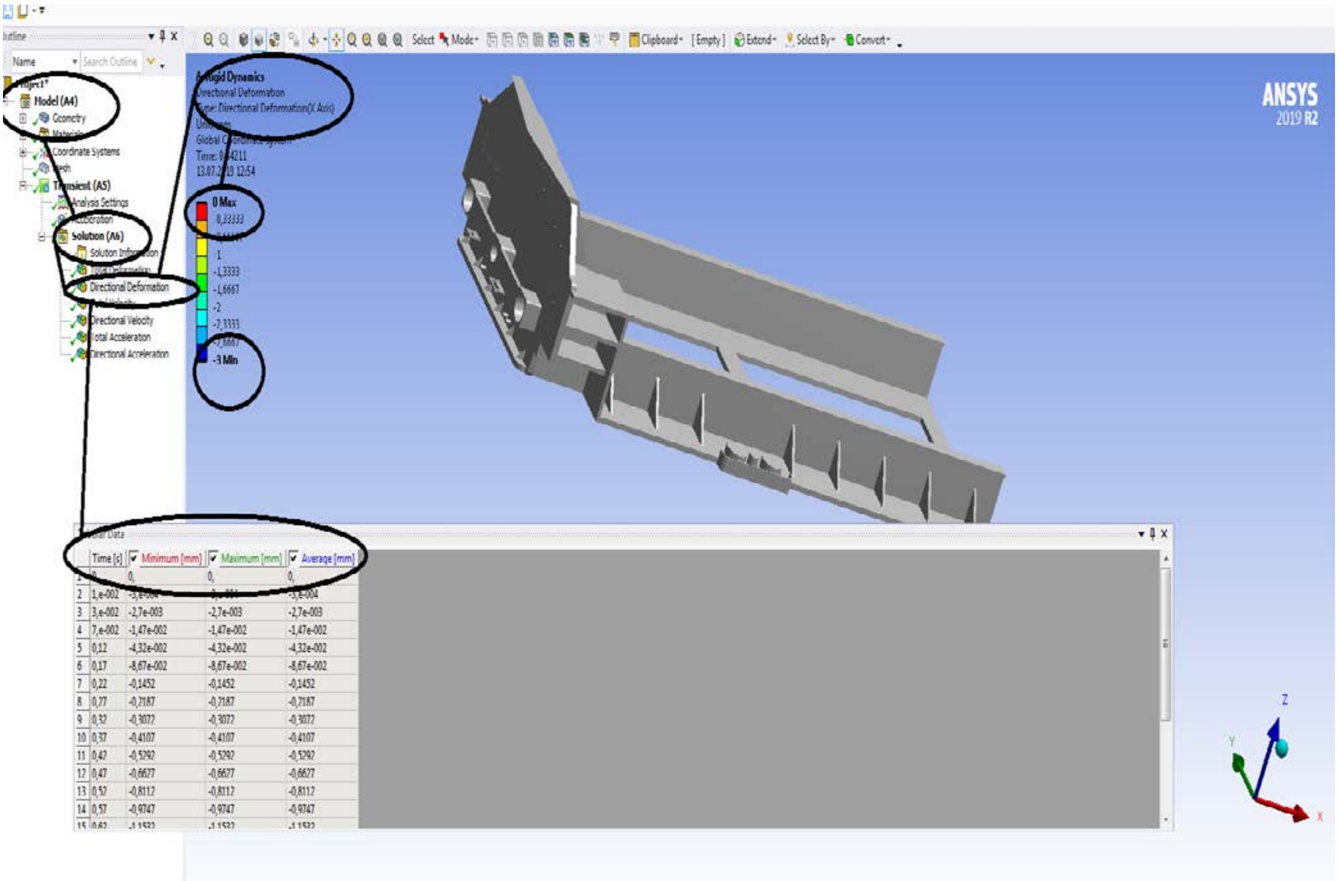


Figura 372 - Deformații direcționale pe axa x [mm]

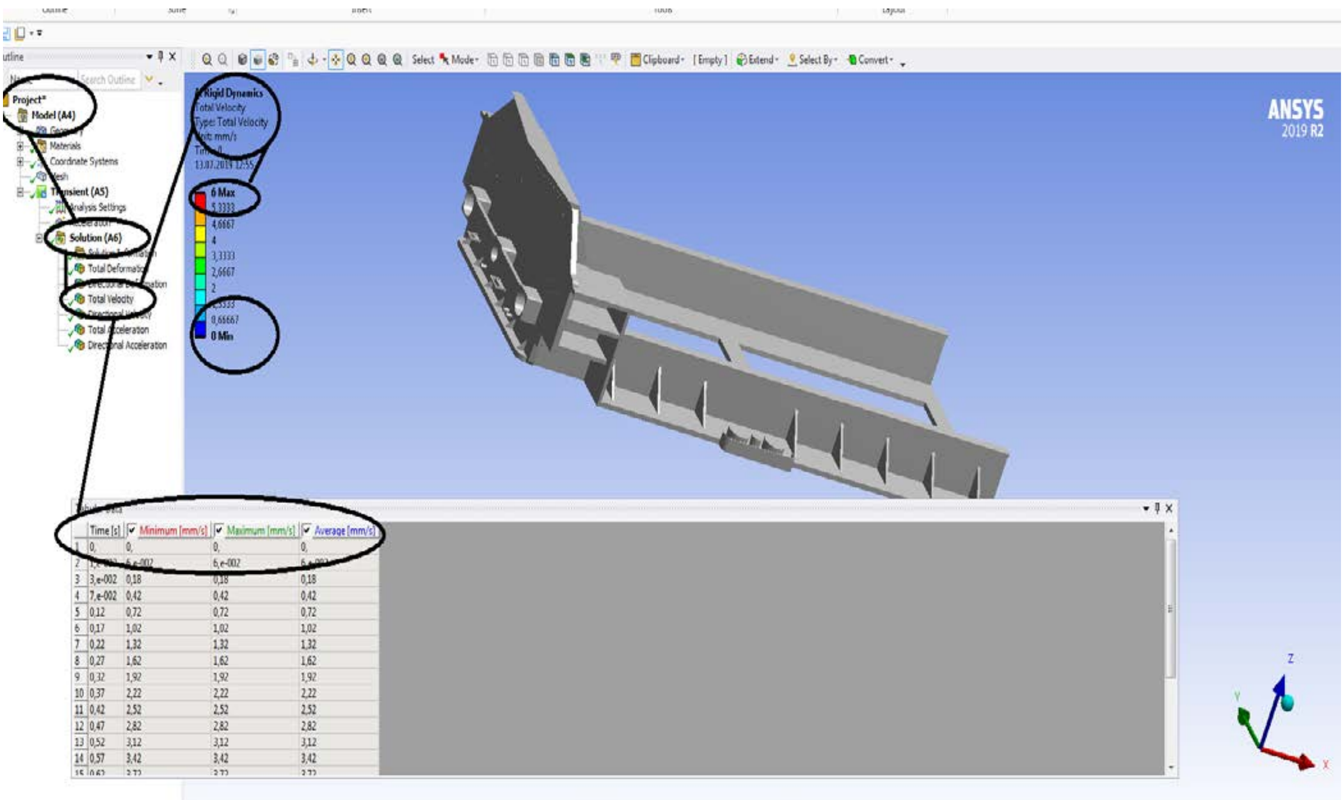


Figura 373 – Vitezele totale [mm/s]

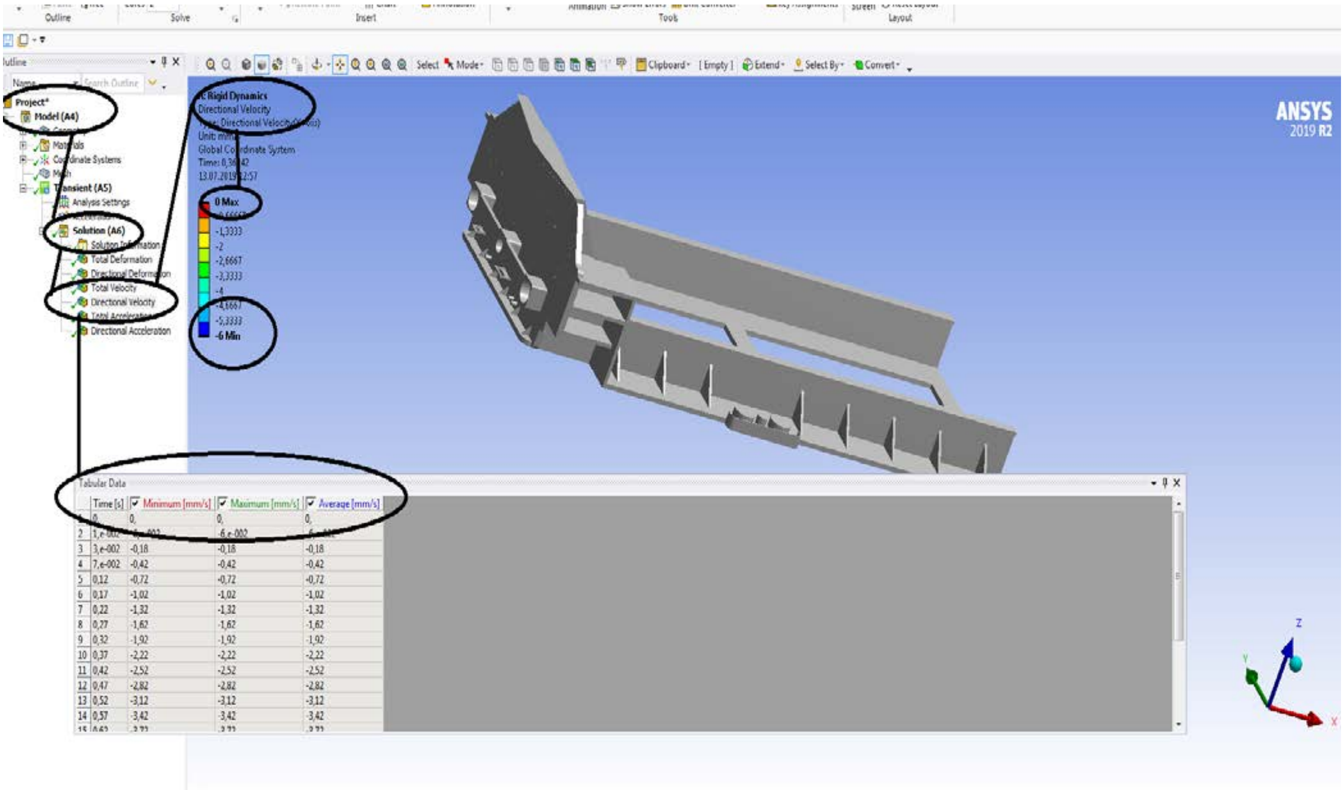


Figura 374 – Vitezele dupa axa OX [mm/s]

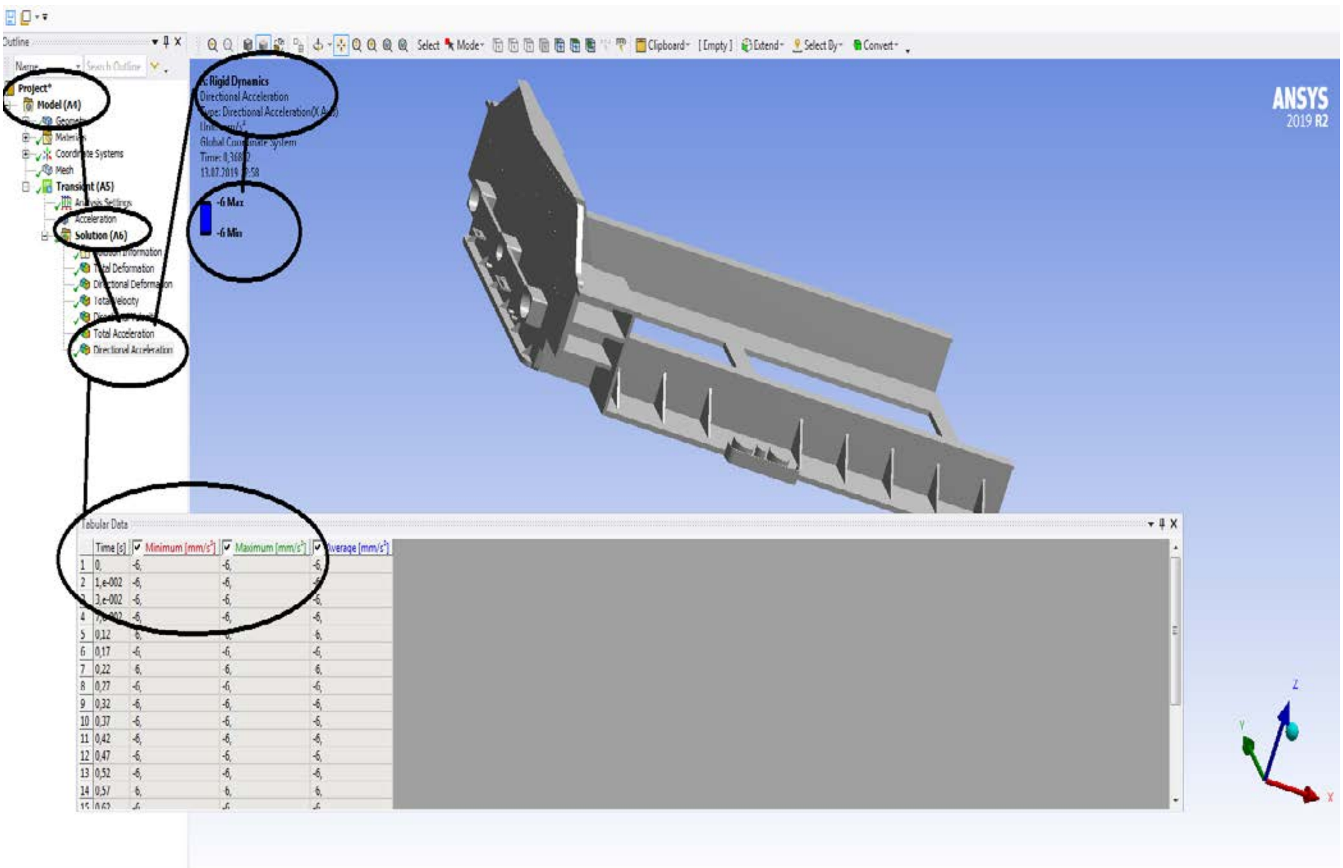


Figura 375 – Acceleratiile dupa axa OX [mm/s^2]

Rigid dynamics

7.11 Sasiu de vagon cale ferata- Acceleratia dupa axa OY

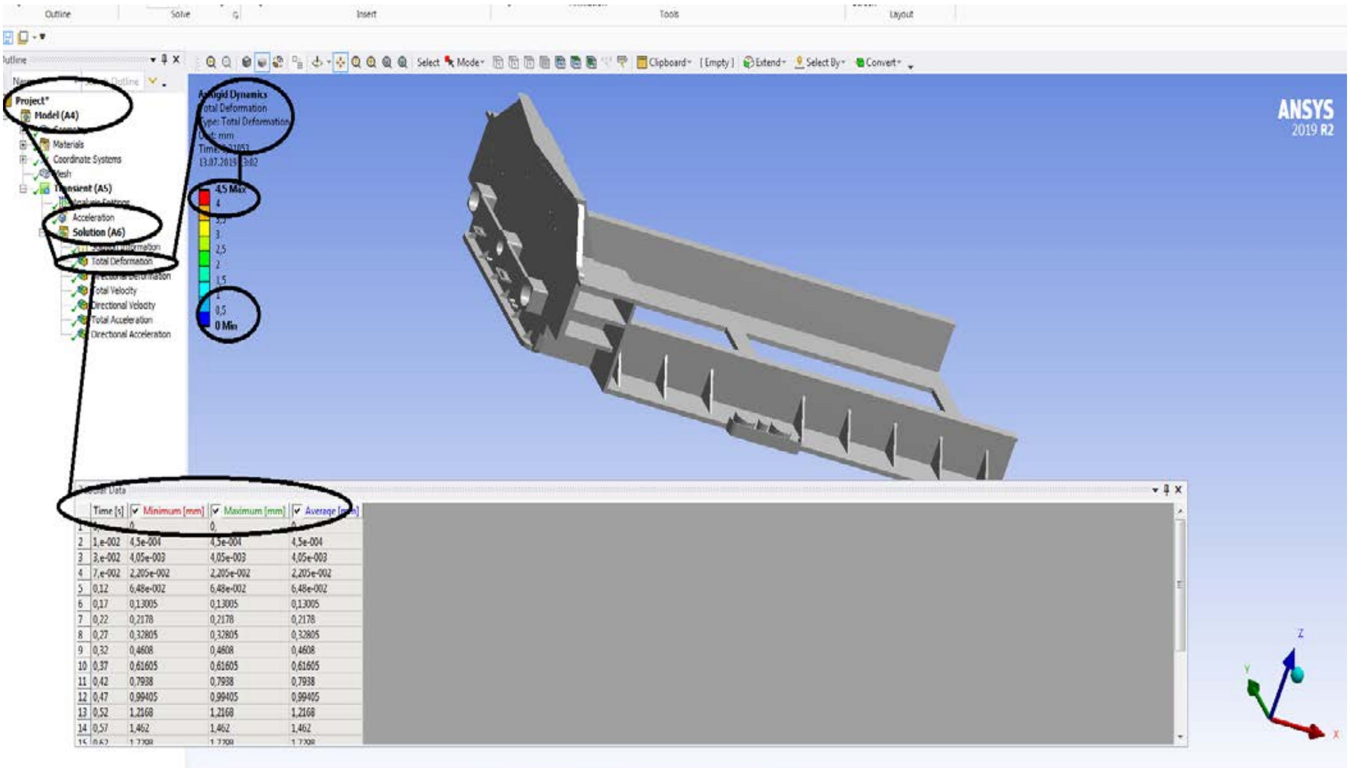


Figura 376 - Deformații totale [mm]

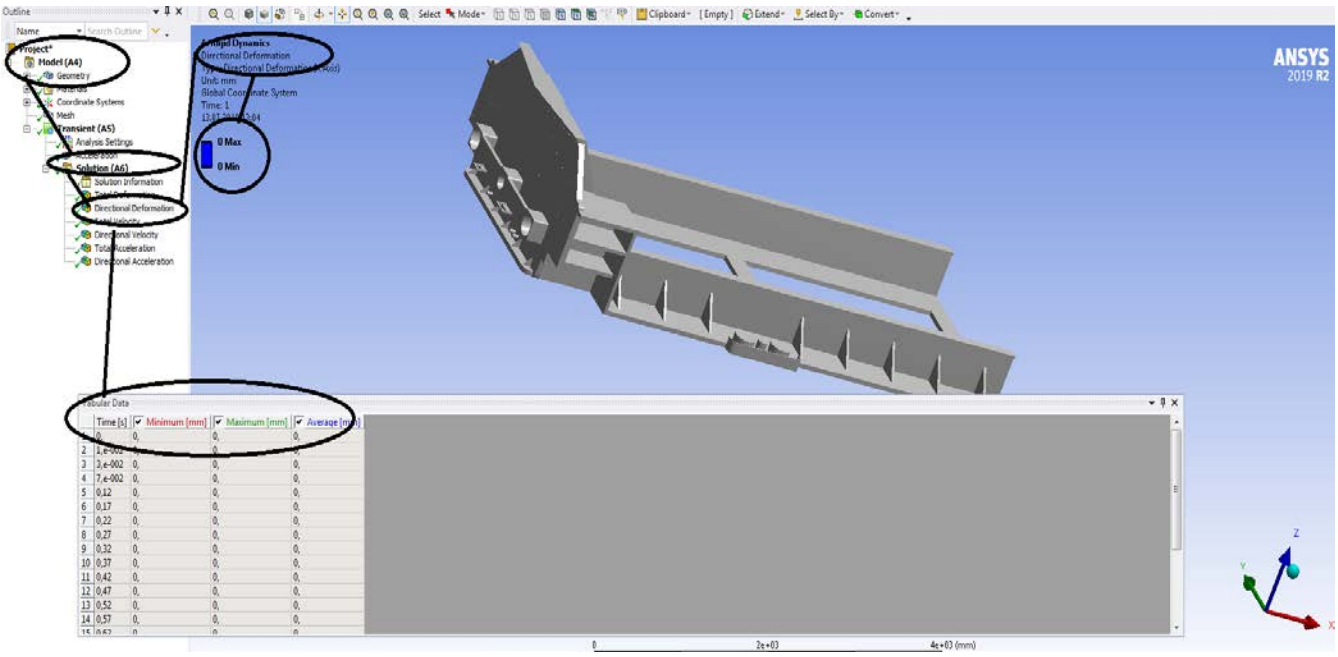


Figura 377 - Deformații direcționale pe axa x [mm]

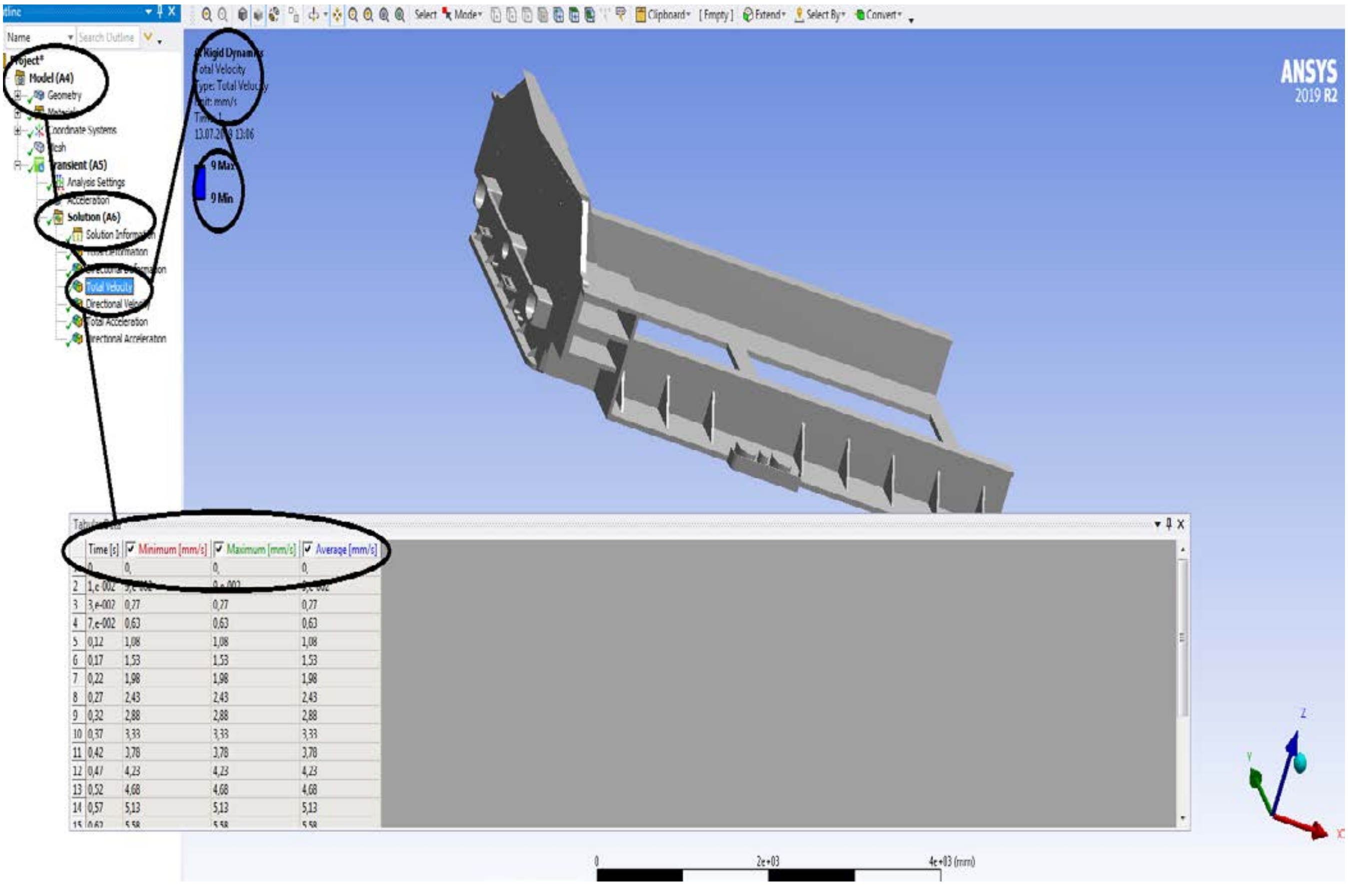


Figura 378 – Vitezele totale [mm/s]

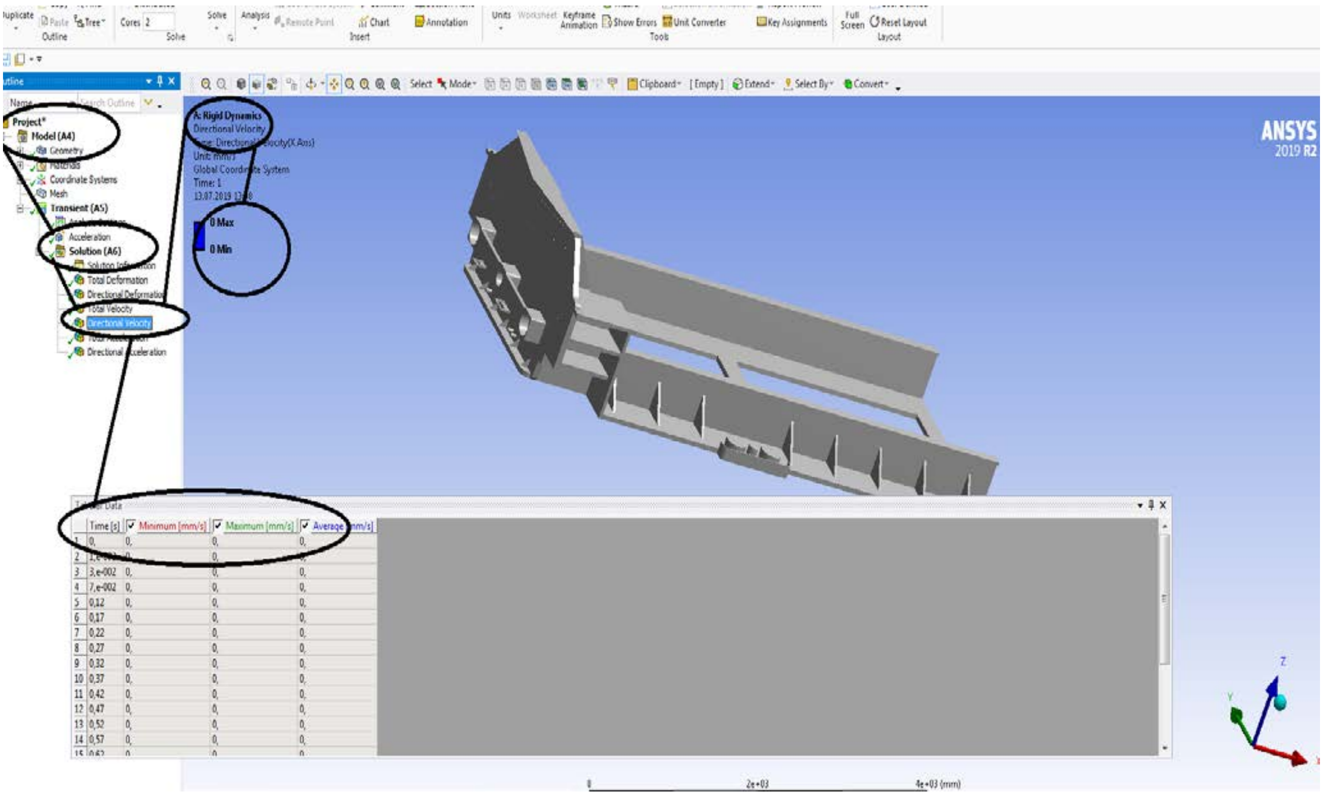


Figura 379 – Vitezele dupa axa OX [mm/s]

Rigid dynamics

7.12 Sasiu de vagon cale ferata- Acceleratia dupa axa OZ

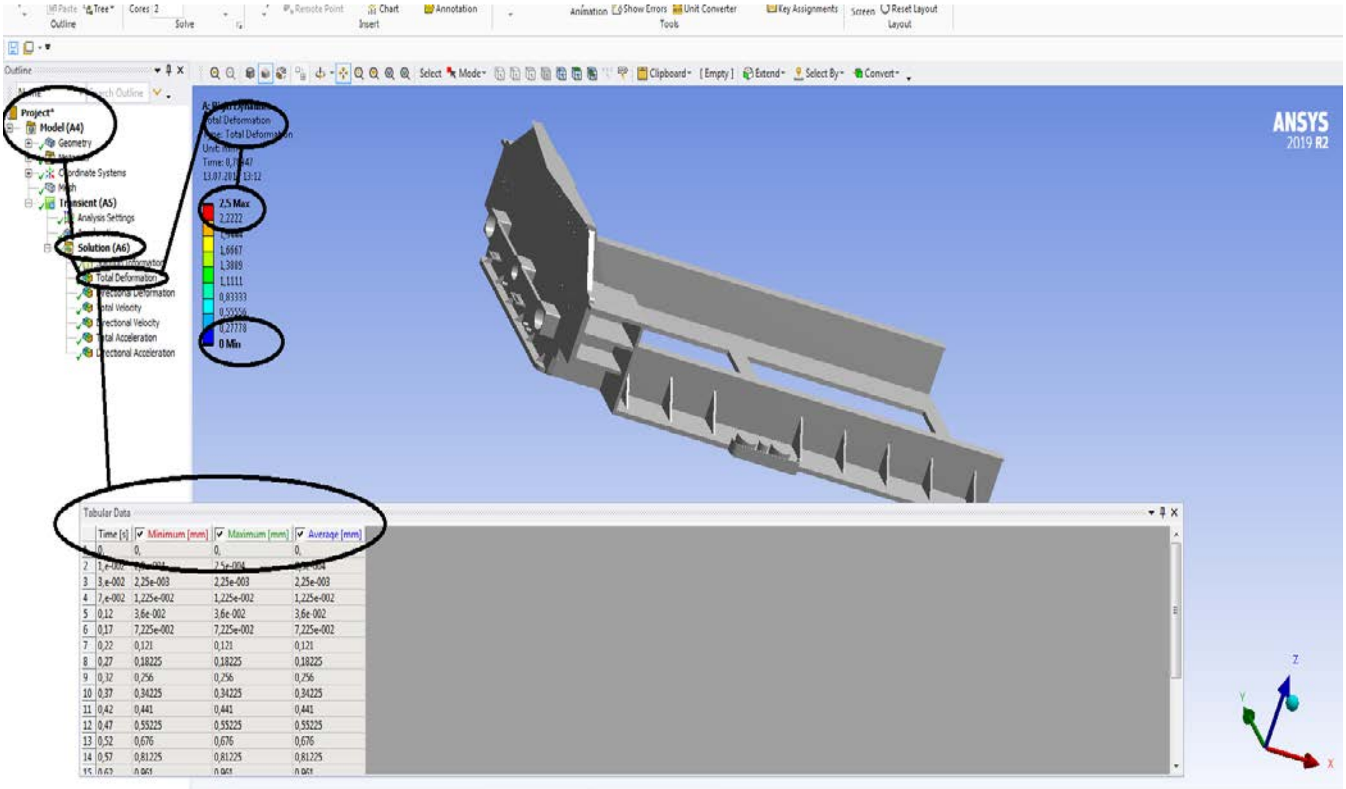


Figura 380 - Deformații totale [mm]

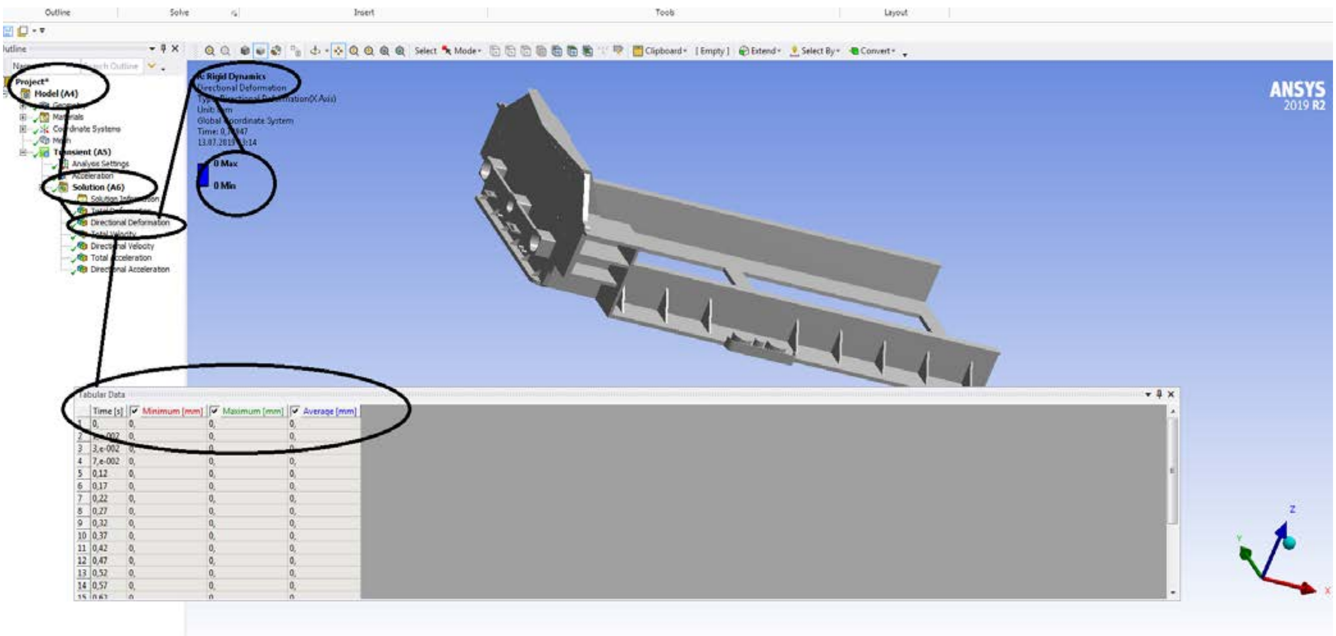


Figura 381 - Deformații direcționale pe axa x [mm]

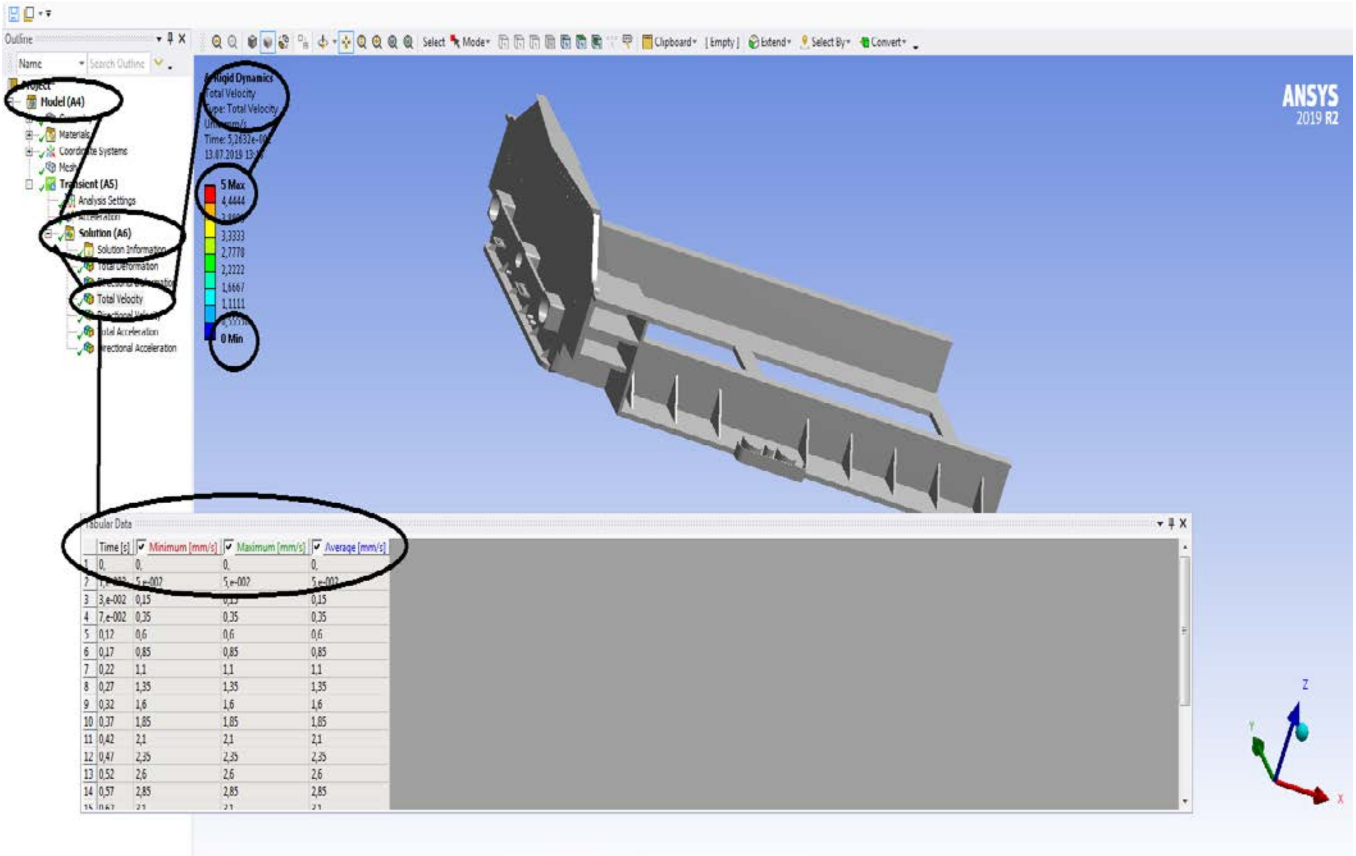


Figura 382 – Vitezele totale [mm/s]

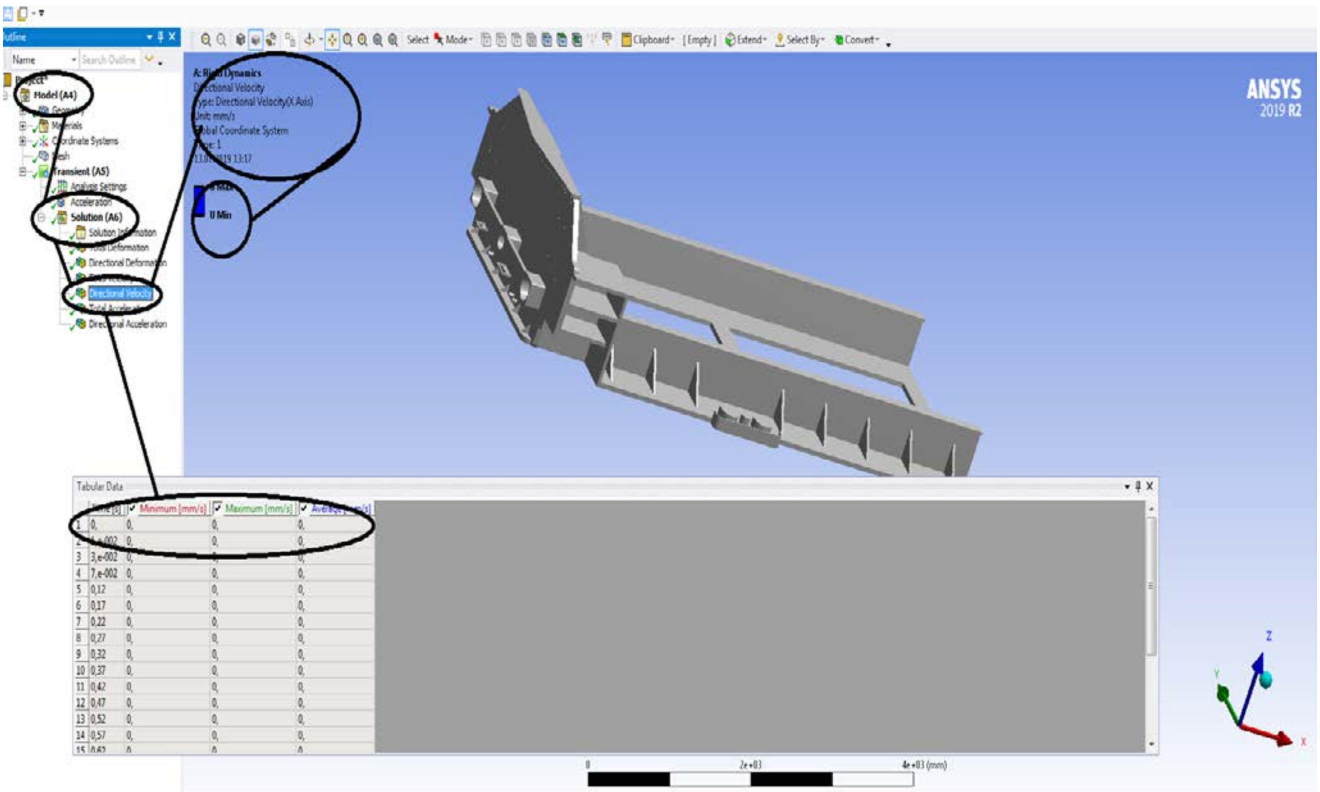


Figura 383 – Vitezele dupa axa OX [mm/s]

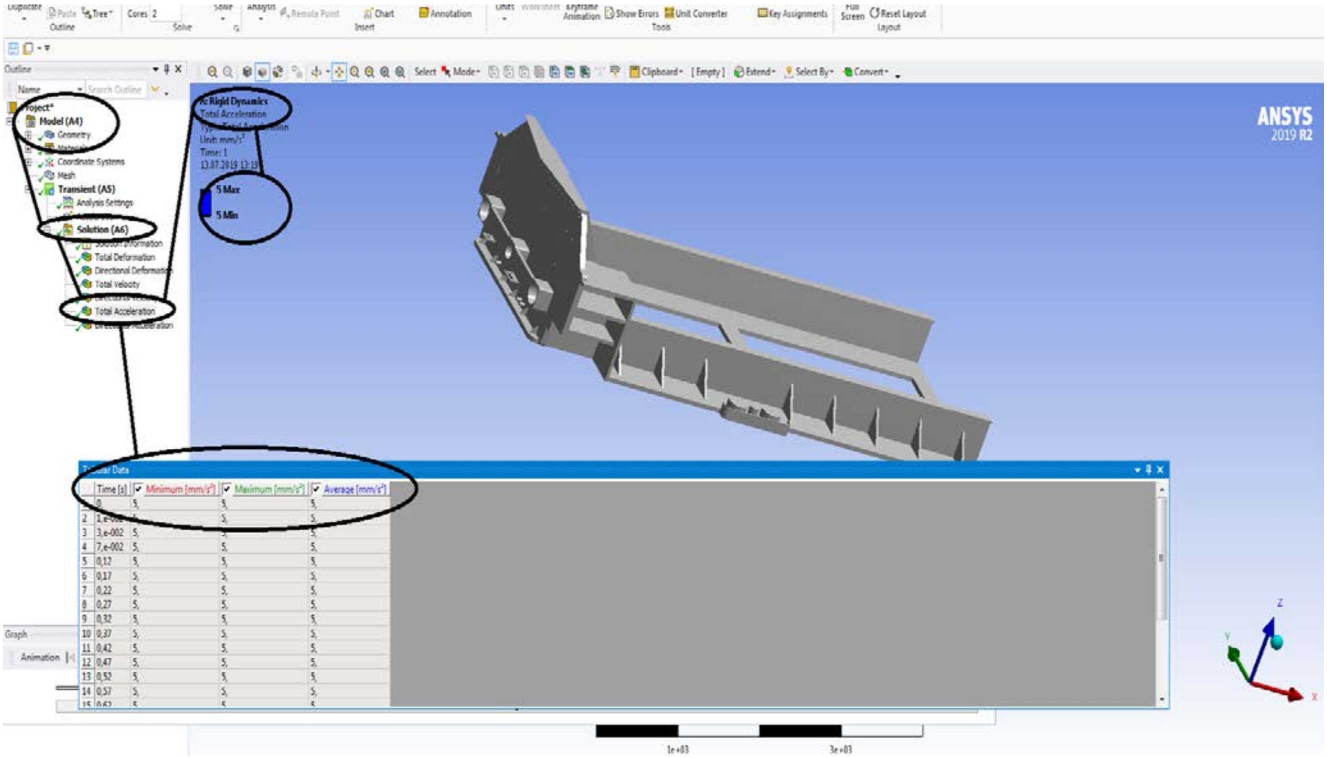


Figura 384 – Acceleratiile totale [mm/s^2]

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Cuprins